Department of the Environment
Central Directorate of Environmental Protection

# UK BLOOD LEAD MONITORING PROGRAMME 1984–1987

## Results for 1985

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## SUMMARY

The Department of the Environment, in conjunction with Local Authorities, Health Authorities and Police Forces, has undertaken an extensive programme to monitor blood lead concentrations annually over the period 1984 to 1987 in the context of the reduction in the maximum permissible lead content of petrol from 0.4 to 0.15 g/l from 1 January 1986. The study includes adults living in heavily trafficked urban areas and in occupational groups particularly exposed to petrol lead; children aged 6-7 years attending schools in heavily trafficked urban areas; and control groups of adults and children in rural areas. The surveys are planned to cover about 1,500 adults and 1,000 children in total each year. Cohorts of adults are being followed, with replacement where necessary owing to moving, etc. For ethical reasons, no child will be sampled more than once, although the schools concerned will be revisited each year; children's blood is also being examined for antibodies to measles and poliomyelitis. Blood samples (all venous) are being analysed for lead by atomic absorption spectrophotometry (AAS); considerable efforts are being made to ensure the validity of the analytical results during the period of the study.

Results from all the stages in the quality assurance protocol have shown that the analytical performance of the Southampton laboratory was extremely good in both 1984 and 1985.

Average blood lead concentrations in 1984 and 1985 in both adults and children were generally low and were in line with levels expected on the basis of earlier surveys; only a very small proportion of individuals had raised levels. Detailed statistical analyses have confirmed that blood lead concentrations are related to a range of personal, social and environmental factors including age, sex and smoking and drinking habits.

Blood lead levels in the exposed groups of adults and children were on average just under 1 $\mu$g/100ml lower in 1985 than in 1984; overall changes in the police and control groups were smaller. There was, however, considerable variability in the changes in average blood lead concentrations in the individual surveys, particularly those of children. Levels fell in all social classes and in both categories of age of dwelling, but changes tended to be less marked in those who were older (particularly for men), smoked more, drank more or had lived for more than 15 years at their current address.

# CHAPTER ONE - INTRODUCTION

1.1 The Department of the Environment, in conjunction with Local Authorities, Health Authorities and Police Forces, has undertaken an extensive programme to monitor blood lead concentrations annually over the period 1984 to 1987 in the context of the reduction in the maximum permissible lead content of petrol from 0.4 to 0.15 g/l from 1st January 1986. This report contains a detailed statistical analysis of the results for the surveys carried out in 1985 and makes comparisons with results for 1984. Preliminary results for 1984 were published in the Digest of Environmental Protection and Water Statistics No 8 (1); results of a detailed statistical analysis of the results for 1984 are contained in Pollution Report No 22 (2). Preliminary results for 1985 were published in the Digest of Environmental Protection and Water Statistics No 9 (3).

1.2 The background to the Monitoring Programme is that in 1981, following the publication of the "Lawther Report" (4), the Government announced that the maximum permissible lead content of petrol would be reduced from 0.4 g/l to 0.15 g/l - the lowest level that can be used in current car engines - by the end of 1985 (5, 6). In April 1983, in response to the Royal Commission on Environmental Pollution's 9th Report (7) the Government accepted (8) the recommendation that, as a logical further step, the remaining lead in petrol should start to be phased out as soon as practicable throughout the European Economic Community. The Government also accepted the recommendation that the body burden of lead in man should be monitored before and after the change to low lead petrol. The current monitoring programme was announced by the Environment Minister, William Waldegrave, in May 1984 (9). Its aim is to investigate changes in blood lead concentrations over the period 1984-1987 and to assess in broad terms the effect of the reduction in the lead content of petrol. The programme is being carried out under the aegis of the Steering Committee on Environmental Lead Monitoring (SCELM). The Steering Committee is chaired by a senior Scientist from the Department of the Environment and its members include representatives from other Government Departments, the Local Authority Associations and experts in the lead field - see Appendix A. In addition to overseeing the Blood Lead Monitoring Programme, the Committee has a co-ordination and evaluation role for both local authority and central government research and monitoring of lead in air, dust, food and water.

## Protocol of the Monitoring Programme

1.3 Pollution Report No 22 (2) contains a full description of the protocol for the Monitoring Programme covering the design and timing of the surveys, the background information collected on the questionnaire, the representativeness of the samples and the validation of questionnaire coding and computer input.

1.4 In brief, based on the experience of the two large surveys of blood lead levels carried out in 1979 and 1981 under an EEC Directive (10, 11, 12), and in the light of information available on blood lead levels both in the UK (13) and in remote populations (14, 15, 16), annual surveys have been designed to cover approximately 2,500 people, concentrating on those in the general population potentially exposed to petrol lead together with rural "controls". Sampling is being carried out by local authorities working with district health authorities; the procedures ensure confidentiality of personal data and close liaison with the volunteer's family doctor. Each local survey covers about 100 people (this number is based on considerations of statistical "power" (17, 18) to detect differences in blood lead levels between groups) who are each asked to give a small sample of blood: these surveys include about 900 adults living in houses bordering heavily trafficked roads in London, Birmingham, Bristol, Liverpool, Manchester and Sheffield; in addition, it was planned to include 300 police officers in three Forces, 100 London taxi drivers and 300 adults in a rural village in South West England where it was known that air and blood lead concentrations were low (19, 20). As many as possible of the adults who were sampled in 1984 are being re-tested annually because the variability in serial blood lead concentrations in individuals is much less than that found in a random group of people (21). There is a detailed discussion of likely follow-up rates, based on studies in Bristol (22, 23) and on information about movers (24) and mortgages (25, 26), in Appendix C of Pollution Report No 22 (2). There are also planned surveys of 1,000 children aged 6-7 who attend schools situated on heavily trafficked roads. For ethical reasons (27, 28, 29) each child is being sampled only once; however the same schools are being revisited each year. The surveys of children are being linked with investigations by the National Institute for Biological Standards and Control (Hampstead, London NW3) into their immune status to measles and poliomyelitis. The places in which surveys were planned are shown in Figure 1; a list of those authorities which participated in 1985 is given in Appendix B.

## Blood Sampling and Analysis

1.5 As lead concentrations in capillary (finger prick) blood samples have been found (30, 31) to be on average some 30 to 40% higher than in corresponding venous samples (ie those taken from a vein with a syringe), and because of problems of contamination encountered in earlier studies (11, 32), the SCELM decided that all the blood samples in the Monitoring Programme must be venous.

1.6 Considerable efforts have been made to ensure the validity of the blood lead analyses during the study. The quality assurance aspects have been described in full elsewhere (2, 33). In brief, detailed instructions have been given on the taking of the blood samples which are transferred to specially prepared EDTA blood lead tubes, a stock of which sufficient for the four year programme was obtained from one production run from a reliable manufacturer; the "blank" value of the tubes at 1 ml volume was less than 0.1 ug/100ml. Blood lead analysis is being carried out using microsampling flame atomic absorption spectrophotometry (MSF-AAS) (34). A novel internal quality control (IQC) procedure has been instituted based on the principles given by Westgard et al (35). Quantities of IQC material sufficient for the whole period of the study were prepared at about 7, 14 and 27 ug/100ml; their exact lead content has been established by isotope dilution mass spectrometry (at a USA laboratory). Each of the three IQC samples is analysed both before and after each set of five survey specimens which are analysed in triplicate. No survey results are accepted unless all IQC results are within predefined limits. A random 20% of all survey samples (and all those over 20 µg/100ml) are being re-analysed by a newly developed procedure involving electrothermal atomisation and atomic absorption (ETA-AAS) with L'vov platform atomisation and Zeeman background correction (36). And a random 10% of all survey samples (and all those over 20 µg/100ml) are being re-analysed by another laboratory (Glasgow Royal Infirmary) which is known to produce reliable blood lead data.

1.7 The results from the quality assurance programme in 1984 were given in Chapter 2 of the Pollution Report No 22 (2). Quality assurance results for 1985, and comparisons with those for 1984, are described in detail in Chapter 2 of this Report by Dr H T Delves, Director of the Trace Element Unit at the University of Southampton.

## Timing of Surveys

1.8 Although seasonal variability in blood lead concentrations has been found to be much less marked in the UK (13, 21) than in the USA (37, 38, 39), it has been specified that whenever a survey was carried out in 1984, it should be repeated at, or as close as possible to, the same time of year in 1985, 1986 and 1987.

## Background Information

1.9 The forms used to collect background information on each participant in 1985 were only modified very slightly from those used in 1984. The questions cover age, sex, occupation [on the basis of which participants are assigned to one of the Registrar General's social classes (40)], ethnic origin, (for adults) smoking habits [since tobacco smoke contains lead (41)] and drinking habits, age of dwelling and length of residence, and possible exposure to lead (a list of twenty industries or occupations which may involve exposure to lead is given in Appendix F). A copy of the adult questionnaire is reproduced in Appendix D, and a copy of the child questionnaire in Appendix E. The questions used in the EEC Suveys (11, 12) on the drinking of alcoholic beverages had been found to be unsatisfactory, and so the type of questions used in both the General Household Survey (GHS) (26) and the Regional Heart Study (42) were adopted; they attempt to quantify both the amount and frequency of drinking. The GHS Report for 1978 (43) included a full description of the methods used in their "drinking" section and commented on the difficulties in collecting such information. Social surveys have consistently recorded lower levels of alcohol consumption than would be expected from statistics on alcohol sales (44); there are several contributory explanations (26). The results have subsequently been categorised in a manner similar to the Quantity/Frequency (QF) index used for the GHS, as shown in the following table:

Classification of Drinking Habits*

| Frequency | Number of units+ | | |
|---|---|---|---|
| | 1 - 2 | 3 - 6 | 6 |
| Daily/most days<br>Weekends | Frequent light | Moderate | Heavier |
| Once or twice per month | Infrequent light | | Moderate |
| Special occasions | Occasional | | |
| None | Teetotal | | |

* Based on the Quantity/Frequency index used in the GHS (26).

+ One unit is a single whisky, gin or brandy, a glass of wine, sherry or port, or half a pint of beer.

As the numbers of participants in some of the drinking categories were too small in several of the surveys to give reliable results, those for the "infrequent light" and "frequent light" groups were combined; similarly, results were combined for social classes I and II, and for social classes IV and V.

## Validation of Questionnaire Coding and Computer Input

1.10 The comprehensive checking and coding procedures for the questionnaires, the validation of the computer input and the further "plausibility" checks on the 1984 results are described in Chapter 1 of Pollution Report No 22 (2). The same procedures were followed for the 1985 surveys. In addition, for those adults who took part in both years, the background information provided in 1985 was compared with that for 1984. As a result, a very small number of amendments was made to the data for 1984, eg there were three people for whom the given sex in 1984 was incorrect (two "men" were in fact women and one "woman" a man).

## Representativeness

1.11 The representativeness of the samples of both adults and children in 1984 was checked in detail against information from the General Household Survey (26, 45) and the National Dwelling and Housing Survey (46) - See Appendix C of Pollution Report No 22 (2). It was found that the surveys of adults were fairly similar to the general population in terms of age, social class and smoking habits (the information on drinking habits was not comparable with that from other surveys). For children, the results on social class, presence of siblings, length of residence, and (except in one area) age of dwelling were broadly in line with information from other sources. Similar checks have been carried out for the 1985 surveys, with similar results (for the adults, this is to be expected, since approximately 80% took part in both years); detailed figures are given in Tables C1 to C7 in Appendix C.

1.12 In addition, the characteristics have been examined of those adults who participated in 1984 and who subsequently did and did not also participate in 1985. Comparisons of the percentages of people in each of the various sub categories of the main factors, together with the corresponding average blood lead concentrations, are shown separately for men and women in Table C8 of Appendix C. Those who dropped out appeared to be reasonably similar to those who continued to participate.

## Statistical Analysis

1.13 The frequency distributions of blood lead concentrations were found to be skewed; they were approximately lognormal (47) and so geometric means (GM) have been used. The geometric coefficient of variation (GCV) (48) has been used as a measure of the variability inherent in blood lead values. The association between blood lead concentration and, for example, age - allowing for smoking and drinking habits, age of dwelling, etc - was examined by multiple classification analysis (49) (essentially multiple regression with dummy variables). Further details of the statistical terms and methods used are given in Appendix C.

# CHAPTER TWO - QUALITY ASSURANCE OF BLOOD LEAD ANALYSES

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2.1 The protocol for controlling the accuracy of blood lead analyses, which has been described in detail elsewhere (2, 33), consists of:

(a) the use of a single batch of low lead blood collection tubes for all survey specimens;

(b) calibration of every analytical run using matrix matched standards prepared from portions of the same pool of a low lead bovine blood specimen, and using invariant acceptance limits for each of the nine calibrating standards;

(c) control of every analytical run by analysing portions of the same internal quality control (IQC) specimens immediately following the calibrating standards and thereafter following every set of 5 survey specimens; invariant acceptance limits are assigned to each set of three IQC specimens;

(d) within-laboratory re-analysis by a different analytical method of a subset of at leat 20% of all survey specimens plus all specimens with lead content greater than 20μg/100ml;

(e) re-analysis by an external laboratory of at least 10% of all survey specimens; and

(f) participation in external quality assessment programmes for blood lead analysis.

The efficacy of these measures in controlling analytical accuracy and minimising analytical bias during the study period is shown in the following discussion.

## Internal Quality Control (IQC)

2.2 The mean blood lead concentrations found in the IQC specimens analysed concurrently with the 1985 specimens from the different survey locations (Table 1) agree well with each other and with the target values. Mean relative bias values derived from these data (Table 2) ranged from -0.21 μg/100ml to +0.19 μg/100ml with an average for all surveys of +0.076 µg/100ml showing the absence of any substantial analytical bias of blood lead data between surveys for 1985 and for any survey area between 1984 and 1985.

## Within-Laboratory re-analysis

2.3 A total 656 (25.6%) of 1985 survey specimens were re-analysed by electrothermal atomisation and atomic absorption spectrometry (ETA-AAS) (36,50) during the period August 1986 to January 1987. The agreement with the initial analyses done by the primary method, microsampling flame atomic absorption (MSF-AAS) (34), between June 1985 and February 1986 was excellent (Table 3). The quality of the blood specimens was generally better than in 1984 so that without excluding any data, 94.1% of the differences were within ±2.5 µg/100ml. The mean difference (MSF-AAS minus ETA-AAS) of +0.168 µg/100ml was very similar to the +0.114 µg/100ml obtained for the 1984 survey specimens; The distribution of the differences (Figure 2) confirmed the absence of any substantial analytical bias between the two methods throughout the study period.

## External re-analysis of survey specimens

2.4 A subset of 289 (11.2%) of the 1985 survey specimens selected from the 656 specimens mentioned above were re-analysed by ETA-AAS at the laboratory of Drs Fell and Halls at Glasgow Royal Infirmary. A comparison of the results from 261 of these specimens (excluding Bexley/Greenwich) is given in Figure 3. The mean difference between the two laboratories of +0.98 µg/100ml was slightly smaller than in the previous comparison of 1984 specimens and more than 90% of differences were within the range +2 to -4 µg/100ml.

Regression results for comparisons of three sets of data: MSF-AAS and ETA-AAS from Southampton and ETA-AAS from Glasgow, show excellent inter- as well as intra-laboratory agreement.

| Analytical technique and laboratory | Results for regression equation $Y = MX + C$ (µg/100ml) | | |
|---|---|---|---|
| | Slope(M) | Intercept(C) | Correlation Coefficient |
| MSF-AAS - Southampton(X)<br>ETA-AAS - Glasgow(Y) | 0.9242 | +0.1181 | 0.9484 |
| MSF-AAS - Southampton(X)<br>ETA-AAS - Southampton(Y) | 0.9857 | +0.0397 | 0.9754 |
| ETA-AAS - Southampton(X)<br>ETA-AAS - Glasgow(Y) | 0.9411 | +0.031 | 0.976 |

These, together with the absence of any bias in the Southampton data for 1984 and 1985 (Figure 2), confirm a small consistent bias between the blood lead results from the Southampton and Glasgow laboratories, the latter being lower.

## External Quality Assurance Programmes

2.5 Evidence of accuracy of the analytical data from Southampton during the period of measurement of the 1985 specimens is given, for both analytical methods, in Figure 4.

## Conclusions

2.6 Accuracy of blood lead measurements has been maintained during analysis of the 1985 survey specimens and there has been no substantial change in analytical bias since the start of the study.

## CHAPTER THREE - RESULTS FOR 1984

3.1 A full set of results for 1984 for each group of adults and children samples is described in Chapter 3 of Pollution Report No 22 (2). The distributions of blood lead concentrations in each of the surveys, together with the geometric mean (adjusted for age, smoking and drinking habits, etc) are illustrated in Figure 5 in "box plot" form (51) - see also paragraph C.7 in Appendix C (the survey of around 30 children in Manchester, where the geometric mean concentration was 9.9 µg/100ml is not shown). Average blood lead concentrations in both the exposed adults and the controls were generally low and were in line with levels expected on the basis of earlier surveys in the same cities. Average concentrations in children were also low and were lower than the levels found in the EEC Surveys in both children of leadworkers and children living around leadworks (11, 12). Only very few individuals had elevated levels; most of these were found to be exposed to a specific "adventitious" source of lead.

3.2 Some of the characteristics of participants, for example smoking and drinking alcoholic beverages, were associated with each other. Thus regression analyses (49, 52) were performed to assess their independent effects; these results are described in Chapter 4 of Pollution Report No 22 (2). They confirmed the results of the similar analyses which were carried out on the data from the EEC Blood Lead Surveys in 1979 and 1981 (11, 12, 13). Average blood lead concentrations in 1984 were found to be significantly related to several personal, social and environmental factors; they

- were higher in men than in women by about 30%, but levels in boys and girls (aged 6 to 7 years) were about the same;
- tended to rise with age in both men and women up to around 50 years of age and then level off;
- were not related to social class in adults, but children of manual workers had slightly higher levels than those of non-manual workers;
- were not related to ethnic origin in either adults or children;
- increased with increasing levels of smoking in both men and women;
- increased with increasing levels of drinking in both men and women;
- were slightly higher in those living in older (pre 1945) dwellings;
- were not related to length of residence;
- were only slightly higher in those "occupationally" exposed to lead (in a minor way) or exposed to lead through another member of the household; and
- in adults, varied markedly across the country, being 20-30% higher in Liverpool and Manchester than in London.

3.3 The pattern of blood lead concentrations with age and sex were closely in line with those from the EEC Surveys (13) and from studies in Birmingham (53) and the United States (54). The relatively small effect of social class was also found in the EEC Surveys (12, 13) and is supported by results from the Regional Heart Study (42) where average blood lead concentrations in manual workers were just 4% (0.6 µg/100ml) higher than in non-manual workers. The results for ethnic origin, which are based on only small number of non-white participants, contrast strongly with those found in some studies the United States (37, 38, 54), although blood lead levels in white and black adults living in large urban areas of the USA were almost identical (55). However, together with results from the EEC Surveys in 1981 (12), from a dietary study in Harrow (56) and earlier studies in Birmingham (32, 57) the UK results indicate that black and Asian children do not in general have higher blood lead levels than white children. Similar results to those on smoking and drinking habits have been found in many studies both in the UK (13, 42, 53) and in other countries (58, 59, 60, 61, 62, 63). The differences in blood lead concentrations between those living in pre-1945 and post-1945 dwellings were smaller than had been found in the EEC Surveys, which were of the order of 1.5 µg/100ml (13). Results on length of residence were similar to those from the EEC Surveys (11, 12). Very few participants had been living at their current address for less than a year; as blood lead concentrations rise fairly rapidly on exposure to a source of lead (64, 65) the body burden of those sampled would, in general, have been in equilibrium with their environment. These results have been discussed in more detail elsewhere (2, 66).

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## CHAPTER FOUR - RESULTS FOR 1985

4.1 The numbers of participants in the surveys in 1984 fell slightly below those originally planned, but it was anticipated that in 1985 there would be additional surveys of adults and children in Brent, of adults living on a major road and of taxi drivers in Lambeth, and of officers on traffic duties from the Devon and Cornwall Constabulary and the West Midlands Police. In total, just over 2,500 people participated in 1985; these included nearly 1,100 adults who were exposed to petrol lead (of which 300 were police officers), 400 adult "controls" and just over 1,000 children. This was lower than expected because the response in the surveys of adults in Brent and Lambeth was below that anticipated, the survey of taxi drivers did not take place, and while the survey of traffic police in Devon and Cornwall covered officers stationed in Exeter, Paignton and Plymouth, the West Midlands Police decided not to participate; in addition, it was not possible to repeat the survey of children in Manchester.

4.2 The geometric mean (GM) blood lead concentrations and geometric coefficients of variation (GCV) for the main groups, split by sex, are shown in Table 4. As had been found in the EEC surveys (11, 12), in other studies around the world (54, 58, 59, 60) and in the surveys in the Monitoring Programme in 1984 (2, 66), levels in men were on average about 30% above those in women. However, as had also been found previously, there were virtually no differences between average blood lead concentrations in boys and girls; in addition, there were again no large or consistent differences in each of the locations sampled. Hence (as for 1984) all results for adults have been given separately for men and women, but those for boys and girls have been combined. The frequency distributions of blood lead concentrations in the main groups are illustrated in Figure 6.

4.3 Of the 1,500 adults included in the surveys, only 15 (1.0%) had blood lead concentrations above 25 µg/100ml, the level above which the DHSS advise (67) that the person's environment should be investigated for sources of lead and steps taken to reduce exposure. This is lower than the corresponding number in 1984, but is to be expected given that around 80% of those sampled in 1984 were resampled in 1985 (see paragraph 5.4 below) and that follow-up investigations were carried out on all but a few of those with blood lead concentrations above 25 µg/100ml in 1984. Of the 15, 11 were men (1.3% of the men) and 4 were women (0.6%). As shown in Table 5, two thirds of the elevated concentrations were in the range 25-30 µg/100ml and only two were above 35 µg/100ml, the upper reference level in the 1979-1981 EEC Blood Lead Surveys (10). Of the 1,000 children included in the surveys, only 9 (0.9%) were above 25 μg/100ml and just one child was above 35 μg/100ml.

4.4 The results of the follow-up investigations, given in Table 6, are similar to those from 1984 (see Table 7 in Pollution Report No 22). For nearly half of those followed up (in only two cases was follow-up not possible) the probable source of lead was either decorating or DIY activity or there was a possibility of minor occupational exposure (eg plumber). For about a third of those followed up (5 adults and 2 children) no identifiable reasons could be found for the elevated blood lead concentration.

4.5 The distributions of blood lead concentrations in 1985 for each of the surveys are shown in Table 7, together with the GM and GCV; these results correspond to those in Table 8 of Pollution Report No 22 (2). (For the reasons given in paragraph 3.9 of that Pollution Report, those with blood lead concentrations above 25 μg/100ml have been excluded from the summary statistics - and from the comparisons of survey and group means described in Chapter 5 below.) These distributions are illustrated in "box plot" form in Figure 7. As in 1984, for adults the levels in Liverpool and Manchester tended to be higher than in other parts of the country, but the results for children showed less geographical variation.

4.6 Detailed breakdowns of the results for each of the surveys in 1985 for age, social class, ethnic origin, smoking habits, drinking habits, age of dwelling, length of residence, occupational exposure and "other" factors (for children) are given in Tables 8 to 17; these correspond to Tables 9 to 18 in Pollution Report No 22 (2).

4.7 The relationships between blood lead concentrations and the individual characteristics recorded in the surveys were very similar to those observed in 1984. As noted in Chapter 3, some of these characteristics were associated with each other and so multiple regression analysis (see Appendix C) was used to assess their independent effects; these results are described in paragraphs 4.8 to 4.10 below. However the unadjusted results for adults on smoking and drinking habits again showed (Table 13 and Figure 8) that

(a) within each drinking category, average blood lead concentrations tended to rise with increases in smoking; and

(b) within each smoking category, average blood lead concentrations tended to rise with the QF index.

4.8 The multiple regression analyses were carried out in a very similar manner to those for the 1984 surveys. As the distributions of blood lead concentrations for the groups of adults living on major roads, the police officers and the controls were all reasonably similar, the results for all groups of adults were combined; however, separate models were fitted for men and women. The results for children including the small number from the control village in south west England, were not analysed separately by sex (see paragraph 4.2). Data for any individual were included only if all the items of information for that person were known. The results described below were based on 808 men, 686 women and 973 children. As the distributions of blood lead concentrations were lognormal, the logarithm of blood lead was used as the dependent variable. The proportions of the variability explained by the regression models were similar to those for the 1984 results: the "$R^2$" values for adults were 20-30%, in line with earlier results (13), but for children the value was lower at around 10%.

4.9 The results of the regression analyses for the variation of blood lead concentration with age in adults are illustrated in Figure 9; those for social class, ethnic origin, smoking habits, drinking habits, age of dwelling, length of residence and exposure to lead are given in Table 18 and (except ethnic origin and exposure to lead) illustrated in Figure 10; and those for geographical location are given in Table 19 (the geometric means are also shown in Figure 7).

4.10 In general, the various factors were found to be related to blood lead concentrations in much the same ways as in 1984 - and as found in the EEC surveys (11, 12, 13). These relationships are summarised in paragraph 3.2 above, and are discussed further in Chapter 5 below in the context of changes in blood lead levels between 1984 and 1985.

## CHAPTER FIVE - CHANGES IN BLOOD LEAD CONCENTRATIONS BETWEEN 1984 AND 1985

5.1 The distributions of blood lead concentrations for all those sampled in 1984 and 1985 are presented, for each of the main groups, in "box plot" form in Figure 11. These illustrate that for both the men and the women in the exposed groups, not only the medians but the whole distributions shifted downwards slightly in 1985 compared with 1984. There were noticeably smaller differences between the two years for both the police(men) and for the controls. The changes in the distributions for children were similar to those in the groups of exposed adults.

5.2 The blood lead distributions for all those adults sampled in 1984 or 1985 are illustrated in "box plot" form for each of the individual surveys in Figures 12(a) - (c). These show that in the separate "exposed" groups (as in aggregate) there were in general downward shifts for both men and women in both the geometric means and the overall distributions, although this was less marked in Manchester [Figure 12(b)]. For the two police forces which were sampled in both years, there was a decrease in the levels in Greater Manchester, but a general increase in London for the Metropolitan force [Figure 12(c)]. In the control groups there was some downward movement in blood lead levels for both the men and the women in Sutton Coldfield (Birmingham 3), but there was virtually no overall change in the distributions of levels in North Petherton [Figure 12(c)].

5.3 The numbers of participants in each of the surveys in 1984 and 1985 (excluding those with blood lead concentrations above 25 µg/100ml in either year) are shown in Table 20, together with the follow-up rates in the surveys of adults. For those adults living on major roads, the follow-up rates ranged from 58% to 96%, with an overall figure of nearly 80% for both men and women. As had been expected, the follow-up rate for police officers was lower, at around 60%, but those for the controls were slightly higher than for the exposed groups. (There is a full discussion of migration and other losses from the surveys in paragraphs C.14 to C.17 in Appendix C of Pollution Report No 22 (2).)

5.4 For adults - but not for children - it is possible to make detailed comparisons of changes in blood lead concentrations between 1984 and 1985 based on results from those sampled in both years (as described in paragraph 1.3 above, each child is being sampled only once, but the same schools are being re-visited each year). The percentage changes in the geometric means of the serial blood lead concentrations for each survey are shown in Table 21. In the exposed groups, falls in average levels ranged up to 14%, but it is noticeable that in some areas the percentage falls for men and women were substantially different. Overall, the falls were 6% for men and 9% for women (just under 1 µg/100ml). In one of the police forces there was a fall in average blood lead level, but in the other an increase; these average out to a slight rise (less than 1%). There were only small changes in average levels in the control group in rural south west England (North Petherton), but that in Birmingham (Sutton Coldfield) showed falls comparable with those in the exposed groups; the combined results were falls of about 5% for men and 2% for women. For the individual surveys, all changes in mean blood lead concentration of 7% or more were statistically significant at the 5% level, as, additionally, was the 4% fall for men in North Petherton. The overall changes for men and women in the exposed groups were both statistically significant; for the control groups the fall for the men was statistically significant but that for the women was not. (In Table 21, those changes which were not statistically significant have been marked "ns".)

5.5 In addition, it is possible to examine the distributions of the changes in blood lead levels of the individual participants. These are shown in Figure 13 for the three main groups, with the "exposed" and "controls" split by sex. Those with lower levels in 1985 appear to the left of the vertical line at 1.0 on the horizontal axis. In the exposed groups, 62% of the men and 70% of the women had lower levels in 1985, while for the police(men) almost exactly half were lower and half higher; in the controls, just under 60% of both men and women had lower levels in 1985.

5.6 The serial blood lead concentrations for individual participants can be shown for each of the surveys in scatterplots such as those in Figures 14(a) - (m). In these diagrams, if a person's blood lead level were unchanged in 1985 from that in 1984, the plotted point would lie on the straight line running at 45° from the bottom left to the top right of the figure; those with higher levels in 1985 would be above the line, those with lower levels below it. Where the average falls in blood lead concentrations in the exposed groups were of the order of 10%, eg in Bristol [Figures 14(c) and (d)], Waltham Forest [14(f)] and for women in Sheffield [14(h)] it is particularly clear that there is a tendency for the points to lie below the 45° line. For the two police forces, the points for the Greater Manchester Police in Figure 14(i) are predominantly below the 45° line whilst those for the Metropolitan Police in Figure 14(j) - the only survey of adults to show a marked increase in mean level - tend to lie above the line. In the control groups, the diagrams show that in Birmingham 3 (Sutton Coldfield) there was a general reduction in blood lead levels between 1984 and 1985 [Figure 14(k)] whereas in North Petherton there was little overall change for either men or women (Figures 14(l) and (m), respectively).

5.7 The distributions of blood lead concentrations for each of the surveys of children in 1984 and 1985 are shown in "box plot" form in Figure 15. The Figure clearly shows a general downward shift in the distributions for Birmingham, Sheffield and (especially) Bexley/Greenwich, virtually no change in Waltham Forest and a rise in levels in Bristol.

5.8 The percentage changes in the average levels (adjusted for age of dwelling, etc) for each of the surveys of children are shown in Table 21. Although the overall average fall of about 9% (just under 1 µg/100ml) was similar to those in the groups of exposed adults, the changes in the five separate surveys ranged from an increase of 7% in Bristol to a fall of 19% in Bexley/Greenwich. The three falls in average blood lead levels were statistically significant. To some extent, it would be expected that the average levels in the surveys of children might be more volatile than those for adults, since in each year the children were "random" samples - rather than cohorts as for the adults; but the range of the observed changes is somewhat surprising given that in the vast majority of cases the same schools were revisited (in one authority one school was added and in another one school dropped out and two were added) and that (broadly) children of the same age were sampled at the same time of year.

5.9 In view of the apparently greater variability in the children's blood lead levels, results were examined for each school within each of the authorities. Although in some cases the numbers of children concerned were small, it was found that there were decreases in mean levels (not adjusted for age of dwelling, etc) for all the schools in Bexley/Greenwich and in Birmingham, and in a majority of schools in Sheffield; in Waltham Forest, the same number of schools had increases in levels as had decreases; and in Bristol all three schools showed increases in levels, ranging from 4 to 10%.

5.10 In addition to looking at changes in blood lead concentrations in the separate surveys, the results from the multiple regression analyses can be used to examine changes in various sub groups of those sampled. Figure 9 illustrates the relationships of blood lead concentrations in adults with age and sex for 1984 and 1985. The general patterns were similar for the two years, although there did seem to be little change in the blood lead levels of men over 50 years of age. Results for social class, smoking habits, drinking habits, age of dwelling and length of residence are illustrated in Figure 10. There were falls in average blood lead concentrations in the four main social class categories for men, women and children (the numbers of people in the "other" category were small). For smoking habits, blood lead levels in men tended to change least in those who smoked the most (very few women smoked more than 20 cigarettes a day). Similarly for drinking habits, blood lead levels tended to change least in those men who were in the "moderate" or "heavier" categories and in those women in the "moderate" category (so few women were in the "heavier" category that no results have been given). Blood lead levels fell in both those who lived in pre-1945 and in post-1945 dwellings; but changed least in those who had been resident at their current address for more than 15 years.

## CHAPTER SIX - ENVIRONMENTAL SOURCES OF LEAD

6.1 Information from the Department of Energy (68), the UK Petroleum Industry Association (69) and Associated Octel Ltd (70) on monthly deliveries of petrol and lead usage indicate that the changeover to low lead petrol, ie from an actual lead content of around 0.38 g/l to around 0.14 g/l, took place over a fairly short period of time at the end of 1985: there was some anticipatory reduction in lead content from the middle of October to the end of November, followed by a sharp drop during the first three weeks of December and a levelling off in the two or three weeks after that (69). A "derogation" (6) was made to the original regulations (5) so that garages in remote areas or with small turnover would not be penalised for selling their stocks of the older (0.4 g/l) petrol after 31st December 1985; however, it is thought that the amount of petrol involved would have been very small. By the end of January 1986, virtually 100 per cent of petrol sales conformed with the low lead specification (69).

6.2 Emissions of lead from petrol driven vehicles depend upon several factors in addition to the lead concentrations, including traffic density, driving patterns, fuel efficiency and fuel density (71, 72). The estimated annual total of emissions of lead from petrol driven vehicles fell from 7.2 thousand tonnes in 1984 to 6.5 thousand tonnes in 1985 (3), a fall of around 10%. This reduction is a combination of several factors, including slight increases in fuel consumption and density which were more than offset by the rapid reduction in the actual lead content of petrol in the last three months of 1985.

6.3 However, emissions of lead during that part of 1985 prior to the start of the changeover to low lead petrol, ie during the time that the blood lead surveys took place, were virtually identical to those in the first nine months of 1984 - just over 5.4 thousand tonnes (73). [In fact, the motor spirit deliveries in October to December 1985 were also very similar to those in the same period of 1984, and so had the lead content of petrol not been lowered, the total lead emissions in 1985 would have been the same as in 1984, ie 7.2 thousand tonnes.]

### Air and Dust Lead Concentrations

6.4 The Steering Committee on Environmental Lead Monitoring is co-ordinating the monitoring of lead in air during 1984-1987 at over 100 sites in 40 towns, villages and remote rural locations (although not all sites will be operating throughout the whole period). The Warren Spring Laboratory in conjunction with Harwell, the

GLC/London Residuary Body and the Transport and Road Research Laboratory has been carrying out a long term programme of monitoring air lead concentrations at 21 sites: a preliminary analysis of the results showed that in the first quarter of 1986 levels fell by about 50% compared with the same period in 1985 (74); the full results from 1976 to March 1986 have been published by the Warren Spring Laboratory (73); the average in air lead concentrations in January-March 1984, 1985 and 1986 are summarised in Table 22. Full details of the location of each of the sites is given in the WSL report, from which this table has been taken; it should be noted that the Glasgow monitoring station is "in an area of significant non-ferrous metal activity" (73). Detailed results of the monitoring in London are also available (70), including data from the site in a tunnel under the River Thames which was only minimally affected by other sources of lead or the weather. These results indicated that air lead concentrations

(a) fell by around 55% at roadside sites - slightly less than the 60-65% reduction in the lead content of petrol - and by around 35% at background sites; and

(b) started to fall at the end of November 1985 and reached a new, lower, value by the beginning of January 1986.

6.5 Concentrations of lead in dust at roadside and background sites in London have also been measured by the Air Pollution Group of London Scientific Services (75). Comparisons of corresponding periods (roughly March to August) in 1985 and 1986 showed that all the roadside sites showed a reduction, in general in the range 10 to 40%; the percentages showed a much wider range than the results for air lead concentrations. In contrast, levels at background sites showed both increases and decreases from 1985 to 1986, suggesting that airborne lead makes only a small contribution to lead in background dusts. The falls in dust lead concentrations at roadside sites were noticeably smaller than the reductions in air lead concentrations, and the authors point out (75) that if, as seems likely, the major part of the lead in dust alongside roads is derived from petrol emissions, then the results suggest a fairly long residence time - a half life of the order of 6 months. In these circumstances, it is likely that the percentage reductions in concentrations will increase with time. However, it remains to be seen whether the decrease in petrol lead emissions will work its way through to background dusts over a longer period.

6.6 As all the sampling in the Blood Lead Monitoring Programme had been completed by November 1985, any apparent reduction in blood lead concentrations between 1984 and 1985 cannot be ascribed to the changeover to low lead petrol at the end of 1985 and the resulting reductions in air and dust lead concentrations.

## Monitoring of Environmental Sources of Lead

6.7 In addition to the reduction in the maximum permissible lead content of petrol, several actions are being taken in the UK (76) to reduce the exposure of the general population to lead from sources including water, canned food, air, industrial processes, decorative paint, cosmetics and ceramic glazes (77, 78). Most surveys to identify problem water supply zones (79, 80, 81) have been carried out; the programme was planned to be completed in 1985, and programmes of remedial action (water treatment changes, source replacement or lead pipe removal as appropriate) will be carried out by 1989 (8). Since 1975, average dietary lead intake has been estimated as part of the continuing annual "Total Diet Study" carried out by the Ministry of Agriculture, Fisheries and Food, in which a number of food groups are prepared as if for eating and analysed for lead (82). In addition, vegetables grown in the UK will be analysed for lead over the period 1983 to 1987. The maximum permitted concentration of lead for most canned foods has been reduced to that for fresh food (1 mg/kg) (83) and the traditional lead soldered tin cans are being replaced by welded (2 piece) cans; samples of canned food are being monitored over the period 1983 to 1988. As described in paragraph 6.4 above, in addition to short term monitoring of lead in air at point sources such as leadworks, monitoring is being carried out during 1984 - 1987 (although not necessarily throughout the whole period) at over 100 sites in 40 towns, villages and remote rural locations (70, 73). A review of emissions from certain industrial processes is being carried out by HM Inspectorate of Pollution to explore the scope for reductions. On paint, no lead will be added to most white gloss, primer and undercoat paints from January 1986, and no lead will be added to coloured paints and varnishes from July 1987 (84, 85). In addition, there has been a national survey of metals in urban soils and dusts (86), and the significance of dust as a possible source of lead exposure for young children through hand-to-mouth activity has been investigated (87).

6.8 The sampling programme for the blood lead monitoring includes two main groups intended to represent people as heavily and as lightly exposed to petrol derived lead as may be found in the general population. It has also been designed to exclude people whose exposure to lead from any particular source other than petrol - for example water - would change by more than it would for the general population. Nevertheless, it is recognised that there will be difficulties in determining the causes of any decline in blood lead concentrations during the survey period because exposure to lead from a number of sources is being reduced simultaneously. However, comparisons of any trends in blood lead concentrations in the "exposed" and "control" groups, together with results from the wide ranging monitoring of environmental sources of lead (mentioned above) should enable a broad assessment to be made.

## CHAPTER SEVEN - CONCLUSIONS

### The Protocol of the Blood Lead Monitoring Programme (Chapter 1)

7.1 The DOE, in conjunction with Local Authorities and Area Health Authorities, has undertaken an extensive programme to monitor blood lead concentrations annually over the period 1984 to 1987. Sampling has taken place in the two years before and is planned for the two years after the reduction in the permitted lead content of petrol (from 0.4 to 0.15 g/1 at the beginning of 1986). The protocol for the Monitoring Programme, which was approved by the SCELM, includes adults living in heavily trafficked urban areas and in occupational groups particularly exposed to petrol lead; children aged 6 to 7 years who attend schools in heavily trafficked urban areas; and controls in rural areas. The surveys are planned to cover about 1,500 adults and 1,000 children in total each year. Cohorts of adults are being followed, with additional recruitment where necessary owing to migration or refusal to continue in the study. For ethical reasons, no child will be sampled more than once, although the schools concerned will be revisited each year; children's blood is also being examined for antibodies to measles and poliomyelitis by the National Institute for Biological Standards and Control.

### Analytical Performance of the University of Southampton Laboratory (Chapter 2)

7.2 The results from all the stages in the quality assurance protocol have shown that the analytical performance of the Trace Element Unit at the University of Southampton was extremely good in both 1984 and 1985:

- the mean relative biases in the IQCs from the standard MSF-AAS analyses in 1985 for the separate survey areas ranged from only -0.19 to +0.21 µg/100ml (Table 1);
- the changes in the mean relative biases between 1984 and 1985 for the separate survey areas ranged from only -0.22 to +0.14 µg/100 ml, and the overall change was only - 0.08 µg/100ml (Table 2);
- there was excellent agreement on the random 20% of samples re-analysed by a different method (ETA-AAS) at Southampton, with 95% of results for 1985 within ±2.5 µg/100ml (Figure 2);
- there was also good agreement on the random 10% of samples re-analysed by another different method at the laboratory at the Glasgow Royal Infirmary (Figure 3); and
- the Trace Element Unit continued to perform well in external quality assurance schemes (Figure 4).

## Blood Lead Concentrations (Chapters 3 and 4)

7.3 The results from the first two years of the UK Blood Lead Monitoring Programme indicated that, as had been found in many studies, the distributions of blood lead concentrations were skewed and were approximately lognormal (Table 7 and Figure 6). Average blood lead concentrations in both the exposed adults and the controls were generally low and were in line with levels expected on the basis of earlier surveys in the same cities (Figures 5 and 7). Average concentrations in children were also low, and were lower than the levels found in the EEC Surveys in both children of leadworkers and children living around leadworks. Only very few individuals had elevated levels; most of these were found to be exposed to a specific "adventitious" source of lead (Tables 5 and 6).

7.4 Multiple regression analyses of the results have confirmed the similar analyses which were carried out on the data from the EEC Surveys. Although only fairly small proportions of the total variability were explained, blood lead levels in 1984 and 1985 were found to be significantly related to several personal, social and environmental factors. Average blood lead concentrations

- were higher in men than in women by about 30%, but levels in boys and girls (aged 6 to 7) were about the same (Table 4);
- tended to rise with age in both men and women up to around 50 years of age and then level off (Figure 9);
- were not related to social class in adults, but children of manual workers had slightly higher levels than those of non-manual workers (Table 18 and Figure 10);
- were not related to ethnic origin in either adults or children;
- increased with increasing levels of smoking in both men and women;
- increased with increasing levels of drinking in both men and women;
- were slightly higher in those living in older (pre-1945) dwellings;
- were not related to length of residence;
- were only very slightly higher in those "occupationally" exposed to lead or exposed to lead through another member of the household; and
- in adults, varied markedly across the country, being 20-30% higher in Liverpool and Manchester than in London (Table 19 and Figures 5 and 7).

## Changes in Blood Lead Concentrations between 1984 and 1985 (Chapter 5)

7.5 For both men and women in the "exposed" groups, not only the median levels but the whole distributions of blood lead concentrations shifted downwards slightly in 1985 compared with 1984. There were noticeably smaller differences between the two years for both policemen and the "controls". The changes in the distributions for children were similar to those in the groups of exposed adults (Figure 11). Broadly similar patterns were observed in the individual surveys (Figures 12 and 15). Roughly 80% of the adults in the exposed and control groups, and 60% of the police officers sampled in 1984, were re-sampled in 1985 (Table 20). Results for these people indicated falls in average blood lead concentrations of just under 1 µg/100ml in the exposed groups - 6% fall for men, 9% for women; little overall change for the policemen; and little movement in one control group but falls in other comparable with those in the exposed groups (Table 21). For children, the overall fall of just under 1 µg/100ml (9%) was similar to that in the exposed groups of adults, but there was more variability within this figure with changes ranging from an increase of 7% to a decrease of 19%. Results from the multiple regression analyses indicated that blood lead concentrations fell in all social classes and in both categories of age of dwelling, but there was a tendency for changes to be less marked in those who were older (particularly in men), smoked more, drank more, or had lived for more than 15 years at their current address (Figures 9 and 10).

## Environmental Sources of Lead (Chapter 6)

7.6 The changeover to low lead (0.15 g/l) petrol took place over a fairly short period of time at the end of 1985. The estimated annual total of emissions of lead from petrol driven vehicles fell from 7.2 thousand tonnes in 1984 to 6.5 thousand tonnes in 1985; however, during that part of 1985 when the blood lead surveys were carried out, lead emissions in 1985 were virtually identical to those in 1984. Air lead concentrations started to fall at the end of November 1985; in the first quarter of 1986 levels fell by about 50% compared with the same period in 1985 (Table 22). Concentrations of lead in dust at roadside sites also fell, by 10 to 40%. The observed reductions in blood lead concentrations between 1984 and 1985 cannot be ascribed to the changeover to low lead petrol and the resulting reductions in air and dust lead concentrations. In addition to the reduction in the maximum permissible lead content of petrol, actions are being taken to reduce the exposure of the general population to lead from sources including water, canned food, air, industrial processes, decorative paint, cosmetics and ceramic glazes.

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But above all the Department recognises with gratitude the invaluable contribution made by those members of the public and the police officers who volunteered to take part and give samples of blood.

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(Table 22 is taken from a report by the Warren Spring Laboratory (73))

22. Average Airborne Lead Concentrations January-March 1984, 1985 and 1986.

## NOTES TO TABLES

### Abbreviations

| | |
|---|---|
| N | The number of participants in each group. The total number for each survey is given in Table 7; in Tables 8 to 17, those with blood lead concentrations over 25 µg/100ml have been excluded (paragraph 4.5). |
| GM | Geometric mean blood lead concentration in microgrammes of lead per 100 millilitres of blood (µg/100ml). |
| GCV | Geometric coefficient of variation (expressed as a percentage). |
| | (See Appendix C for a fuller explanation of these statistical terms) |
| - | Nil; or 0 per cent. |
| .. | Results based on only a very small number of participants and therefore unreliable; or less than ½ per cent. |
| ( ) | Aggregate results based on only small numbers of participants in some surveys and therefore should be treated with caution. |

Exposed Adults - Adults living in houses fronting heavily trafficked urban roads (paragraph 1.4).

Police - Police officers, predominantly on traffic duties (paragraph 1.4).

Controls - People living in areas where exposure to environmental lead - and particularly petrol lead - was known to be low (paragraph 1.4).

Children - Children (the vast majority aged either 6 or 7 years) in the top infant year at primary schools situated on busy major roads or at congested crossroads (paragraph 1.4).

### Rounding

All the percentage figures given in the tables have been rounded individually and so in some cases may not sum to 100. Percentages have been printed in **bold** type.

## Exclusions

As noted above, in Tables 8 to 17, those with blood lead concentrations above 25 µg/100ml have been excluded (paragraph 4.5). Additionally, in Tables 18 and 19, all records with any missing items of data were excluded (paragraph 4.8).

## Contents of Tables

Tables 1 to 3 - give details of the Quality Assurance aspects of the blood lead analyses, including IQC results for 1984.

Table 4 - is a summary of the total numbers and average blood lead concentrations by sex for each of the main groups in the Monitoring Programme.

Tables 5 and 6 - present details of the numbers of people who had blood lead concentrations above 25 µg/100ml; and of the results of the follow-up investigations.

Tables 7 to 17 - show detailed results for the individual surveys. The results for men, women and children are given in separate sections of each table. The ranges of blood lead concentrations in Table 7 are 0-4.9, 5.0-9.9, etc. There are no results for children on smoking habits (Table 11) or drinking alchoholic beverages (Table 12), and results for children on age and length of residence are not given with those for adults in Tables 8 and 16, but separately in Table 17.

Tables 18 and 19 - contain the results of the multiple regression analyses (see Appendix C), based on data for 808 men, 686 women and 973 children for whom full information was available.

Tables 20 and 21 - The numbers of participants in all of the surveys in both 1984 and 1985 are given in Table 20, together with the percentages of those adults who participated in both years (excluding those with blood lead concentrations over 25 µg/100ml in either year). The changes in blood lead concentrations between 1984 and 1985 are summarised in Table 21 (see also paragraphs 5.4 and 5.8).

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## Table 1 Internal Quality Control Results for 1985

| Survey/ Area | IQC I | | | IQC II | | | IQC III | | | Mean relative bias* | No. of IQC sets | No. of samples | Ratio of samples to IQCs |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean+ | SD | RSD% | Mean | SD | RSD% | Mean | SD | RSD% | | | | |
| Birmingham | 6.97 | 0.43 | 6.2 | 14.12 | 0.53 | 3.8 | 26.77 | 0.74 | 2.8 | -0.1867 | 155 | 555 | 3.6 |
| Bristol | 6.91 | 0.51 | 7.4 | 14.16 | 0.61 | 4.3 | 27.10 | 0.84 | 3.1 | -0.0837 | 102 | 336 | 3.3 |
| Liverpool | 6.97 | 0.46 | 6.7 | 14.40 | 0.69 | 4.8 | 26.78 | 0.75 | 2.8 | -0.0903 | 32 | 100 | 3.1 |
| Bexley/Greenwich | 7.42 | 0.48 | 6.5 | 14.44 | 0.53 | 3.7 | 26.75 | 0.54 | 2.0 | +0.0630 | 61 | 233 | 3.8 |
| Brent | 7.17 | 0.48 | 6.6 | 14.03 | 0.62 | 4.4 | 26.71 | 0.71 | 2.7 | -0.1700 | 49 | 163 | 3.3 |
| Lambeth | 7.32 | 0.38 | 5.2 | 14.23 | 0.52 | 3.6 | 27.05 | 0.65 | 2.4 | +0.0596 | 6 | 26 | 4.3 |
| Waltham Forest | 7.37 | 0.49 | 6.6 | 14.11 | 0.55 | 3.9 | 26.67 | 0.69 | 2.6 | -0.0903 | 72 | 271 | 3.8 |
| Manchester | 7.17 | 0.49 | 6.9 | 14.10 | 0.61 | 4.3 | 26.52 | 0.61 | 2.3 | -0.2103 | 30 | 100 | 3.3 |
| Sheffield | 6.97 | 0.52 | 7.5 | 14.07 | 0.63 | 4.5 | 27.07 | 0.80 | 3.0 | -0.1037 | 67 | 225 | 3.4 |
| Devon & Cornwall Police | 7.21 | 0.62 | 8.6 | 14.08 | 0.55 | 3.9 | 26.91 | 0.78 | 2.9 | -0.0737 | 33 | 96 | 2.9 |
| Manchester Police | 7.13 | 0.50 | 7.1 | 13.87 | 0.44 | 3.2 | 26.93 | 0.68 | 2.5 | -0.1640 | 19 | 76 | 4.0 |
| Metropolitan Police | 7.42 | 0.54 | 7.3 | 14.40 | 0.72 | 5.0 | 26.60 | 0.53 | 2.0 | -0.0010 | 20 | 79 | 4.0 |
| North Petherton | 7.53 | 0.47 | 6.2 | 14.43 | 0.62 | 4.4 | 27.04 | 0.85 | 3.2 | +0.1930 | 89 | 298 | 3.3 |
| | | | | | | | | | | | 735 | 2558 | 3.5 |
| IQC Target Values | 7.3 | | | 14.3 | | | 26.9 | | | | | | |
| Mean IQC Values | 7.197 | | | 14.188 | | | 26.839 | | | | | | |
| (SD) | (0.2034) | | | (0.1790) | | | (0.1915) | | | | | | |

+ µg/100ml  * see footnote to Table 2

RSD The relative standard deviation (or coefficient of variation), ie the standard deviation as a percentage of the mean.

## Table 2 Comparisons of IQC Results for 1984 and 1985

| Survey Area | Mean Relative Bias* µg/100ml 1984 | Mean Relative Bias* µg/100ml 1985 | Change in Mean Relative Bias 1984 to 1985 |
|---|---|---|---|
| Birmingham | +0.0163 | -0.1867 | -0.2030 |
| Bristol | -0.1470 | -0.0837 | +0.0637 |
| Liverpool | -0.0836 | -0.0902 | -0.0067 |
| Bexley/Greenwich | +0.1130 | +0.0630 | -0.0500 |
| Brent | - | -0.1700 | - |
| Lambeth | - | +0.0596 | - |
| Waltham Forest | +0.0163 | -0.0903 | -0.1066 |
| Manchester | +0.0130 | -0.2103 | -0.2233 |
| Sheffield | +0.0197 | -0.1037 | -0.1234 |
| Devon & Cornwall Police | - | -0.0737 | - |
| Greater Manchester Police | -0.0303 | -0.1640 | -0.1337 |
| Metropolitan Police | +0.0263 | -0.0003 | -0.0266 |
| North Petherton | +0.0563 | +0.1930 | +0.1367 |
| Average Bias for all surveys relative to 1984 | (0) | -0.07648 | -0.0673 |
| Total number of survey specimens | 2403 | 2558 | |
| Total number of IQC samples | 2040 | 2205 | |

* Mean Relative Bias = $1/3 \sum_{I,II,III}$ [Obs. Mean IQC - Overall Mean IQC(1984)]

**Table 3 Within-laboratory Re-analysis of Lead in Blood Specimens, 1985**

| | Blood specimens from surveys | | | Mean difference in blood lead | Number (per cent) of repeat analyses with differences equal to, or greater than | | | Greatest observed difference |
|---|---|---|---|---|---|---|---|---|
| | | Re-analysed | | | | | | |
| | Total Analysed | Number | Percent of total | µg/100ml* | 2.5 µg/100ml | 3.0µg/100ml | 4.0 µg/100ml | µg/100ml |
| Birmingham | 555 | 140 | **25.2** | -0.55 | 4(2.9) | 2(1.4) | 0 | 3.5 |
| Bristol | 336 | 85 | **25.3** | -0.29 | 3(3.5) | 2(2.4) | 0 | 3.5 |
| Liverpool | 100 | 25 | **25.0** | 0.08 | 5(20) | 3(12) | 2(8) | 7.3 |
| Bexley/Greenwich | 233 | 60 | **25.8** | 0.59 | 3(5) | 3(5) | 3(5) | 5.6 |
| Brent | 163 | 45 | **27.6** | 0.11 | 1(2.2) | 0 | 0 | 2.9 |
| Lambeth | 26 | 6 | **23.1** | 1.57 | 1(17) | 1(17) | 1(17) | 5.0 |
| Waltham Forest | 271 | 70 | **25.8** | 0.48 | 5(7.2) | 3(4.3) | 1(1.4) | 6.4 |
| Manchester | 100 | 25 | **25.0** | 0.81 | 3(12) | 2(8) | 2(8) | 5.0 |
| Sheffield | 225 | 60 | **26.7** | 0.79 | 3(5) | 3(5) | 1(1.7) | 5.4 |
| Devon & Cornwall Police | 96 | 25 | **26.0** | 0.48 | 2(8) | 1(4) | 1(4) | 4.4 |
| Greater Manchester Police | 76 | 20 | **26.3** | -0.72 | 0 | 0 | 0 | 2.3 |
| Metropolitan Police | 79 | 20 | **25.3** | 0.20 | 0 | 0 | 0 | 1.9 |
| North Petherton | 298 | 75 | **25.2** | 0.76 | 9(12) | 6(8) | 5(6.7) | 6.0 |
| Total | 2558 | 656 | **25.6** | 0.168 | 39(5.9) | 26(3.9) | 16(2.4) | 7.3 |

* initial analysis by MSF-AAS, June '85 to Feb '86 minus repeat analysis by ETA-AAS, Aug '86 to Jan '87.

### Table 4 Blood Lead Concentration by Group and Sex, 1985

| Group | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | N | GM+ | GCV(%) | N | GM | GCV(%) |
| Exposed Adults | 412 | 12.0 | 38 | 468 | 8.9 | 47 |
| Police | 228 | 11.0 | 33 | 22 | 8.5 | .. |
| Controls | 189 | 10.5 | 42 | 200 | 7.7 | 49 |
| Children | 503 | 9.4 | 37 | 504 | 8.9 | 37 |

### Table 5 Blood Lead Concentrations above 25 µg/100ml, 1985

| Group | | N | Blood Lead (µg/100ml) | | | Total over 25µg/100ml | |
|---|---|---|---|---|---|---|---|
| | | | 25-30 | 30-35 | Over 35 | N | % |
| Exposed Adults | Men | 412 | 4 | 1 | 1 | 6 | 1.5 |
| | Women | 468 | 3 | 1 | – | 4 | 0.9 |
| Police | Men | 228 | – | – | 1 | 1 | 0.4 |
| | Women | 22 | – | – | – | – | – |
| Controls | Men | 189 | 3 | 1 | – | 4 | 2.2 |
| | Women | 200 | – | – | – | – | – |
| Total Adults | | 1,519 | 10 | 3 | 2 | 15 | 1.0 |
| Children | | 1,007 | 3 | 5 | 1 | 9 | 0.9 |

### Table 6 Results of Follow-up Investigations, 1985

| Group | | Decorating or DIY* | Occupational Exposure** | Other | No identifiable reasons found | No detailed follow-up | Total |
|---|---|---|---|---|---|---|---|
| Adults | Men | 2 | 5 | – | 3 | 1 | 11 |
| | Women | 1 | – | 1 | 2 | – | 4 |
| Children | | 2 | – | 4 | 2 | 1 | 9 |
| Total | | 5 | 5 | 5 | 7 | 2 | 24 |

+ Excluding those over 25 µg/100ml.
GM excludes North Petherton.

* Includes professional painters and decorators.

** Includes "minor" exposure to lead, eg self-employed plumber, maintenance worker.

## Table 7 Percentage Distributions of Blood Lead Concentrations, 1985

| | | | N | Percentage with blood lead concentration in stated range | | | | | | | | GM+ | GCV(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0-5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30-35 | >35 | | |
| Men | Exposed | Birmingham 1 | 45 | - | 27 | 53 | 16 | 2 | 2 | - | - | 12.0 | 35 |
| | | Birmingham 2 | 50 | 2 | 16 | 50 | 24 | 4 | 2 | - | 2 | 12.5 | 34 |
| | | Bristol | 91 | - | 32 | 46 | 16 | 4 | - | 1 | - | 11.6 | 37 |
| | | Liverpool | 44 | - | 16 | 57 | 18 | 5 | 5 | - | - | 12.3 | 35 |
| | | London - Brent | 25 | 4 | 24 | 52 | 16 | 4 | - | - | - | 11.3 | 36 |
| | | Lambeth | 12 | .. | .. | .. | .. | .. | - | - | - | (12.1) | .. |
| | | Waltham Forest | 45 | - | 49 | 40 | 7 | 4 | - | - | - | 10.4 | 37 |
| | | Manchester | 52 | - | 12 | 42 | 38 | 8 | - | - | - | 13.8 | 30 |
| | | Sheffield | 48 | - | 33 | 38 | 15 | 15 | - | - | - | 12.0 | 50 |
| | Police | Devon & Cornwall | 86 | 1 | 43 | 43 | 9 | 2 | - | - | - | 10.5 | 36 |
| | | Greater Manchester | 66 | - | 32 | 56 | 9 | 3 | - | - | - | 11.3 | 31 |
| | | Metropolitan | 76 | - | 32 | 57 | 8 | 4 | - | - | - | 11.3 | 31 |
| | Controls | Birmingham 3 | 53 | - | 45 | 43 | 8 | 4 | - | - | - | 10.0 | 40 |
| | | North Petherton | 136 | 3 | 40 | 35 | 16 | 3 | 2 | 1 | - | 10.7 | 42 |
| Women | Exposed | Birmingham 1 | 58 | 3 | 57 | 26 | 12 | 2 | - | - | - | 9.6 | 48 |
| | | Birmingham 2 | 53 | 8 | 43 | 36 | 11 | 2 | - | - | - | 9.8 | 48 |
| | | Bristol | 99 | 9 | 57 | 26 | 6 | 2 | - | - | - | 8.3 | 48 |
| | | Liverpool | 56 | 4 | 36 | 38 | 14 | 5 | 4 | - | - | 10.8 | 55 |
| | | London - Brent | 38 | 5 | 74 | 18 | - | - | 3 | - | - | 8.0 | 28 |
| | | Lambeth | 14 | .. | .. | .. | .. | .. | - | - | - | (9.3) | .. |
| | | Waltham Forest | 39 | 8 | 79 | 10 | 3 | - | - | - | - | 7.2 | 38 |
| | | Manchester | 48 | - | 44 | 42 | 10 | 2 | - | - | 2 | 10.2 | 38 |
| | | Sheffield | 63 | 2 | 76 | 16 | 6 | - | - | - | - | 8.0 | 38 |
| | Police | Devon & Cornwall | 10 | .. | .. | .. | .. | .. | - | - | - | (8.7) | .. |
| | | Greater Manchester | 9 | .. | .. | .. | .. | .. | - | - | - | (8.5) | .. |
| | | Metropolitan | 3 | .. | .. | .. | .. | .. | - | - | - | .. | .. |
| | Controls | Birmingham 3 | 49 | 8 | 65 | 22 | 2 | 2 | - | - | - | 7.6 | 45 |
| | | North Petherton | 151 | 13 | 60 | 21 | 5 | 1 | - | - | - | 7.7 | 51 |

/continued

**Table 7 Percentage Distributions of Blood Lead Concentrations, 1985 (Contd)**

| | | | N | Percentage with blood lead concentration in stated range | | | | | | | | GM+ | GCV(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 0-5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30-35 | >35 | | |
| Children | Exposed | Birmingham | 240 | 3 | 59 | 30 | 7 | 1 | - | 1 | - | 8.9 | 41 |
| | | Bristol | 146 | 1 | 51 | 44 | 5 | - | - | - | - | 9.6 | 34 |
| | | London - Bexley/Greenwich | 217 | 1 | 64 | 31 | 3 | - | 1 | .. | - | 8.9 | 31 |
| | | - Brent | 93 | - | 52 | 42 | 5 | 1 | - | - | - | 9.8 | 35 |
| | | - Waltham Forest | 187 | 1 | 57 | 32 | 9 | 1 | - | 1 | - | 9.5 | 36 |
| | | Sheffield | 114 | 4 | 59 | 25 | 8 | 1 | 1 | 1 | 1 | 8.8 | 46 |
| | Controls | North Petherton | 10 | .. | .. | .. | .. | .. | - | - | - | (7.4) | .. |

+ Excluding those over 25 µg/100ml.

( ) Result based on small number of participants and therefore should be treated with caution.

.. Result unreliable; or less than ½%.

## Table 8 Blood Lead Concentration by Age Group, 1985

| | | | N | 16-29 | | 30-44 | | 45-59 | | 60-74 | | 75 & over | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM | % | GM |
| Men | Exposed | Birmingham 1 | 44 | 14 | 10.7 | 30 | 13.0 | 32 | 12.2 | 20 | 11.8 | 5 | .. |
| | | Birmingham 2 | 48 | 23 | 11.3 | 31 | 11.8 | 23 | 13.7 | 21 | 13.1 | 2 | .. |
| | | Bristol | 90 | 14 | 9.5 | 39 | 11.6 | 33 | 11.9 | 11 | 13.5 | 2 | .. |
| | | Liverpool | 42 | 5 | .. | 24 | 11.9 | 38 | 12.9 | 31 | 13.0 | 2 | .. |
| | | London - Brent | 25 | 24 | 9.2 | 12 | .. | 20 | 11.4 | 32 | .. | 12 | .. |
| | | - Lambeth | 12 | .. | .. | .. | .. | - | - | .. | .. | .. | .. |
| | | - Waltham Forest | 45 | 16 | 8.2 | 33 | 10.8 | 16 | 12.2 | 33 | 10.6 | 2 | .. |
| | | Manchester | 52 | 13 | 11.6 | 15 | 13.4 | 31 | 15.1 | 31 | 14.2 | 10 | .. |
| | | Sheffield | 48 | 17 | 8.8 | 38 | 13.1 | 25 | 13.3 | 21 | 11.5 | - | - |
| | Police | Devon and Cornwall | 85 | 32 | 10.1 | 56 | 10.8 | 12 | 10.0 | - | - | - | - |
| | | Greater Manchester | 66 | 45 | 10.9 | 50 | 11.8 | 5 | 10.6 | - | - | - | - |
| | | Metropolitan | 76 | 30 | 11.4 | 51 | 11.0 | 18 | 12.2 | - | - | - | - |
| | Controls | Birmingham 3 | 53 | 19 | 8.6 | 30 | 9.4 | 34 | 11.1 | 15 | 10.2 | 2 | .. |
| | | North Petherton | 132 | 13 | 9.0 | 32 | 11.1 | 23 | 11.0 | 27 | 11.1 | 5 | 9.6 |
| Women | Exposed | Birmingham 1 | 58 | 17 | 7.4 | 29 | 10.2 | 26 | 9.4 | 24 | 11.4 | 3 | .. |
| | | Birmingham 2 | 53 | 30 | 7.6 | 25 | 11.0 | 28 | 10.5 | 15 | 11.5 | 2 | .. |
| | | Bristol | 99 | 19 | 7.1 | 44 | 7.9 | 25 | 9.5 | 11 | 9.5 | - | - |
| | | Liverpool | 54 | 7 | .. | 31 | 8.5 | 37 | 12.2 | 17 | 13.0 | 7 | .. |
| | | London - Brent | 37 | 11 | .. | 27 | 7.7 | 32 | 8.6 | 19 | 7.8 | 11 | .. |
| | | - Lambeth | 14 | .. | .. | .. | .. | - | - | .. | .. | - | - |
| | | - Waltham Forest | 39 | 10 | .. | 33 | 6.3 | 28 | 8.3 | 21 | 7.6 | 8 | .. |
| | | Manchester | 47 | 17 | 8.0 | 36 | 9.4 | 23 | 12.6 | 19 | 11.7 | 4 | .. |
| | | Sheffield | 63 | 14 | 6.9 | 46 | 7.5 | 32 | 9.0 | 8 | .. | - | - |
| | Police | Devon and Cornwall | 10 | 40 | 8.3 | 60 | 9.0 | - | - | - | - | - | - |
| | | Greater Manchester | 9 | 100 | 8.5 | - | - | - | - | - | - | - | - |
| | | Metropolitan | 3 | .. | .. | .. | .. | - | - | - | - | - | - |
| | Controls | Birmingham 3 | 49 | 22 | 6.1 | 27 | 7.7 | 39 | 7.8 | 10 | .. | 2 | .. |
| | | North Petherton | 151 | 11 | 6.4 | 32 | 7.6 | 26 | 7.7 | 24 | 8.3 | 7 | 9.2 |

## Table 9 Blood Lead Concentration by Social Class, 1985

| | | | N | I & II | | IIInm | | IIIm | | IV & V | | Not known | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM | % | GM |
| Men | Exposed | Birmingham 1 | 44 | 23 | 10.8 | 14 | 11.7 | 55 | 12.9 | 7 | .. | 2 | .. |
| | | Birmingham 2 | 48 | 8 | .. | 6 | .. | 75 | 12.9 | 8 | .. | 2 | .. |
| | | Bristol | 90 | 40 | 11.2 | 12 | 12.4 | 21 | 11.8 | 13 | 12.7 | 4 | .. |
| | | Liverpool | 42 | 29 | 11.9 | 14 | 11.5 | 31 | 13.9 | 26 | 11.6 | - | - |
| | | London - Brent | 25 | 20 | .. | 12 | .. | 40 | 12.1 | 20 | .. | 8 | .. |
| | | - Lambeth | 12 | .. | .. | .. | .. | .. | .. | - | - | .. | .. |
| | | - Waltham Forest | 45 | 22 | 10.8 | 11 | .. | 42 | 11.2 | 24 | 9.4 | - | - |
| | | Manchester | 52 | 15 | 15.2 | 27 | 11.3 | 38 | 14.9 | 19 | 14.6 | - | - |
| | | Sheffield | 48 | 23 | 12.4 | 10 | .. | 46 | 12.3 | 19 | 12.7 | 2 | .. |
| | Police | Devon and Cornwall | 85 | 18 | 8.9 | 82 | 10.8 | - | - | - | - | - | - |
| | | Greater Manchester | 66 | 18 | 10.0 | 82 | 11.6 | - | - | - | - | - | - |
| | | Metropolitan | 76 | 3 | .. | 97 | 11.4 | - | - | - | - | - | - |
| | Controls | Birmingham 3 | 53 | 42 | 9.4 | 13 | 12.0 | 36 | 10.7 | 4 | .. | 6 | .. |
| | | North Petherton | 132 | 36 | 11.2 | 10 | 9.0 | 40 | 11.2 | 14 | 9.4 | - | - |
| Women | Exposed | Birmingham 1 | 58 | 21 | 10.9 | 45 | .. | 9 | 11.7 | 17 | 8.6 | 9 | .. |
| | | Birmingham 2 | 53 | 11 | 9.9 | 30 | 10.6 | 26 | 9.8 | 19 | 10.0 | 13 | 7.7 |
| | | Bristol | 99 | 26 | 8.5 | 57 | 8.1 | 3 | .. | 11 | 9.3 | 3 | .. |
| | | Liverpool | 54 | 28 | 10.3 | 43 | 10.9 | 11 | 10.8 | 11 | 10.6 | 7 | .. |
| | | London - Brent | 37 | 16 | 8.4 | 30 | 7.3 | 16 | 10.2 | 22 | 7.7 | 16 | 7.5 |
| | | - Lambeth | 14 | 14 | .. | 43 | 8.7 | - | - | 43 | 9.7 | - | - |
| | | - Waltham Forest | 39 | 13 | .. | 49 | 6.8 | 15 | 6.8 | 18 | 7.3 | 5 | .. |
| | | Manchester | 47 | 13 | 12.0 | 53 | 10.5 | 4 | .. | 26 | 9.2 | 4 | .. |
| | | Sheffield | 63 | 33 | 7.9 | 35 | 8.1 | 13 | 7.6 | 19 | 7.9 | - | - |
| | Police | Devon and Cornwall | 10 | 10 | .. | 90 | 8.6 | - | - | - | - | - | - |
| | | Greater Manchester | 9 | - | - | 100 | 8.5 | - | - | - | - | - | - |
| | | Metropolitan | 3 | - | - | 100 | .. | - | - | - | - | - | - |
| | Controls | Birmingham 3 | 49 | 14 | 8.1 | 73 | 7.6 | - | - | 12 | 6.7 | - | - |
| | | North Petherton | 151 | 21 | 8.0 | 42 | 7.2 | 11 | 8.1 | 17 | 7.9 | 9 | 9.4 |

/continued

**Table 9 Blood Lead Concentration by Social Class, 1985 (Contd)**

| | | | N | I&II | | IIInm | | IIIm | | IV&V | | Not known | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM | % | GM |
| Children | Exposed | Birmingham | 238 | 33 | 9.3 | 10 | 8.1 | 34 | 9.2 | 20 | 8.4 | 2 | .. |
| | | Bristol | 146 | 13 | 8.9 | 11 | 9.0 | 55 | 10.0 | 14 | 9.0 | 6 | 10.6 |
| | | London - Bexley/Greenwich | 214 | 21 | 8.5 | 14 | 8.9 | 42 | 9.3 | 19 | 8.7 | 5 | 9.3 |
| | | - Brent | 93 | 20 | 10.3 | 24 | 8.8 | 40 | 9.7 | 12 | 11.3 | 4 | .. |
| | | - Waltham Forest | 186 | 20 | 9.6 | 16 | 8.8 | 46 | 9.5 | 17 | 9.2 | 2 | .. |
| | | Sheffield | 111 | 26 | 8.0 | 6 | 6.8 | 39 | 9.2 | 24 | 9.4 | 5 | .. |
| | Controls | North Petherton | 10 | .. | .. | .. | .. | .. | .. | - | - | - | - |

## Table 10 Blood Lead Concentration by Ethnic Origin, 1985

| | | | N | White | | Afr/Carib | | Asian | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM |
| Men | Exposed | Birmingham 1 | 44 | 100 | 12.0 | | | - | - | | |
| | | Birmingham 2 | 48 | 94 | 12.6 | | | 6 | .. | | |
| | | Bristol | 90 | 100 | 11.6 | | | - | - | | |
| | | Liverpool | 42 | 100 | 12.3 | | | - | - | | |
| | | London - Brent | 25 | 76 | 11.3 | | | 24 | 11.6 | | |
| | | - Lambeth | 12 | 67 | 12.5 | | | 33 | 11.4 | | |
| | | - Waltham Forest | 45 | 93 | 10.4 | | | 7 | .. | | |
| | | Manchester | 52 | 96 | 13.7 | | | 4 | .. | | |
| | | Sheffield | 48 | 96 | 12.1 | | | 4 | .. | | |
| | Police | Devon and Cornwall | 85 | 100 | 10.5 | | | - | - | | |
| | | Greater Manchester | 66 | 98 | 11.3 | | | 2 | .. | | |
| | | Metropolitan | 76 | 100 | 11.3 | | | - | - | | |
| | Controls | Birmingham 3 | 53 | 96 | 10.1 | | | 4 | .. | | |
| | | North Petherton | 132 | 99 | 10.7 | | | 1 | .. | | |
| Women | Exposed | Birmingham 1 | 58 | 100 | 9.6 | | | - | - | | |
| | | Birmingham 2 | 53 | 87 | 10.0 | | | 13 | 8.2 | | |
| | | Bristol | 99 | 100 | 8.3 | | | - | - | | |
| | | Liverpool | 54 | 100 | 10.8 | | | - | - | | |
| | | London - Brent | 37 | 86 | 8.1 | | | 14 | 7.7 | | |
| | | - Lambeth | 14 | 79 | 9.0 | | | 21 | .. | | |
| | | - Waltham Forest | 39 | 97 | 7.2 | | | 3 | .. | | |
| | | Manchester | 47 | 98 | 10.3 | | | 2 | .. | | |
| | | Sheffield | 63 | 97 | 8.0 | | | 3 | .. | | |
| | Police | Devon and Cornwall | 10 | 100 | 8.7 | | | - | - | | |
| | | Greater Manchester | 9 | 100 | 8.5 | | | - | - | | |
| | | Metropolitan | 3 | 100 | .. | | | - | - | | |
| | Controls | Birmingham 3 | 49 | 96 | 7.7 | | | 4 | .. | | |
| | | North Petherton | 151 | 100 | 7.7 | | | - | - | | |

/continued

### Table 10 Blood Lead Concentration by Ethnic Origin, 1985 (Contd)

| | | | N | White | | Afr/Carib | | Asian | | Other | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM |
| Children | Exposed | Birmingham | 238 | 87 | 9.2 | 4 | 6.7 | 8 | 7.9 | 1 | .. |
| | | Bristol | 146 | 92 | 9.8 | 2 | .. | 4 | 6.9 | 2 | .. |
| | | London - Bexley/Greenwich | 214 | 89 | 9.0 | 3 | 9.0 | 3 | 9.5 | 5 | 7.2 |
| | | - Brent | 93 | 31 | 10.2 | 34 | 8.9 | 30 | 10.2 | 4 | 11.6 |
| | | - Waltham Forest | 186 | 72 | 9.6 | 7 | 7.6 | 20 | 9.9 | 1 | .. |
| | | Sheffield | 111 | 82 | 8.4 | 1 | .. | 14 | 11.7 | 3 | .. |
| | Controls | North Petherton | 10 | 100 | 7.4 | - | - | - | - | - | - |

## Table 11 Blood Lead Concentration by Smoking Habits, 1985

| | | | N | Non-smoker | | 1-20 cigs/day | | >20 cigs/day | | Cigar/pipe | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM |
| Men | Exposed | Birmingham 1 | 44 | 52 | 11.3 | 25 | 12.1 | 11 | .. | 11 | .. |
| | | Birmingham 2 | 48 | 56 | 12.7 | 29 | 11.7 | 6 | .. | 8 | .. |
| | | Bristol | 90 | 68 | 10.9 | 17 | 13.0 | 8 | 14.4 | 8 | 12.6 |
| | | Liverpool | 42 | 52 | 10.8 | 26 | 12.9 | 7 | .. | 14 | 14.0 |
| | | London - Brent | 25 | 60 | 10.4 | 24 | 11.9 | 12 | .. | 4 | .. |
| | | - Lambeth | 12 | 50 | 12.2 | 33 | .. | 17 | .. | - | - |
| | | - Waltham Forest | 45 | 67 | 10.1 | 18 | 10.2 | 16 | 11.6 | - | - |
| | | Manchester | 52 | 54 | 12.7 | 27 | 15.5 | 13 | 15.2 | 6 | .. |
| | | Sheffield | 48 | 58 | 11.6 | 19 | 13.4 | 10 | .. | 13 | 10.0 |
| | Police | Devon and Cornwall | 85 | 56 | 10.0 | 19 | 12.1 | 2 | .. | 22 | 10.5 |
| | | Greater Manchester | 66 | 70 | 11.1 | 20 | 11.8 | 3 | .. | 8 | .. |
| | | Metropolitan | 76 | 68 | 11.2 | 17 | 11.7 | 7 | .. | 8 | 11.7 |
| | Controls | Birmingham 3 | 53 | 68 | 9.5 | 21 | 10.7 | 6 | .. | 6 | .. |
| | | North Petherton | 132 | 67 | 10.2 | 14 | 12.6 | 5 | 13.8 | 14 | 10.4 |
| Women | Exposed | Birmingham 1 | 58 | 57 | 9.1 | 40 | 10.2 | 2 | .. | 2 | .. |
| | | Birmingham 2 | 53 | 57 | 9.3 | 34 | 10.2 | 9 | .. | - | - |
| | | Bristol | 99 | 75 | 8.0 | 19 | 9.5 | 5 | .. | 1 | .. |
| | | Liverpool | 54 | 59 | 10.1 | 33 | 12.1 | 6 | .. | 2 | .. |
| | | London - Brent | 37 | 73 | 8.0 | 24 | 7.8 | 3 | .. | - | - |
| | | - Lambeth | 14 | .. | .. | .. | .. | .. | .. | - | - |
| | | - Waltham Forest | 39 | 69 | 7.1 | 28 | 7.4 | 3 | .. | - | - |
| | | Manchester | 47 | 68 | 9.3 | 30 | 12.4 | 2 | .. | - | - |
| | | Sheffield | 63 | 63 | 7.3 | 32 | 9.1 | 5 | .. | - | - |
| | Police | Devon and Cornwall | 10 | 50 | .. | 50 | .. | - | - | - | - |
| | | Greater Manchester | 9 | 67 | 7.2 | 33 | .. | - | - | - | - |
| | | Metropolitan | 3 | .. | .. | - | - | .. | .. | - | - |
| | Controls | Birmingham 3 | 49 | 69 | 7.0 | 24 | 9.4 | 6 | .. | - | - |
| | | North Petherton | 151 | 75 | 7.6 | 24 | 8.4 | 1 | .. | - | - |

## Table 12 Blood Lead Concentration by Drinking Habits - Adults, 1985

| | | | N | Teetotal | | Occasional | | Light | | Moderate | | Heavier | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM | % | GM |
| Men | Exposed | Birmingham 1 | 44 | 11 | .. | 20 | 9.5 | 20 | 13.6 | 32 | 13.2 | 16 | 12.6 |
| | | Birmingham 2 | 48 | 13 | 12.3 | 19 | 12.3 | 8 | .. | 33 | 12.8 | 27 | 12.6 |
| | | Bristol | 90 | 3 | .. | 14 | 10.2 | 27 | 11.1 | 47 | 12.5 | 9 | 12.3 |
| | | Liverpool | 42 | 5 | .. | 24 | 12.1 | 17 | 11.8 | 40 | 12.1 | 14 | 12.7 |
| | | London - Brent | 25 | 12 | .. | 20 | .. | 28 | .. | 28 | .. | 12 | .. |
| | | - Lambeth | 12 | .. | .. | .. | .. | .. | .. | .. | .. | - | - |
| | | - Waltham Forest | 45 | 24 | 10.2 | 38 | 10.0 | 18 | 10.8 | 20 | 11.0 | - | - |
| | | Manchester | 52 | 25 | 12.9 | 21 | 12.7 | 10 | .. | 27 | 15.9 | 17 | 12.8 |
| | | Sheffield | 48 | 4 | .. | 8 | .. | 21 | 9.2 | 35 | 12.5 | 31 | 13.9 |
| | Police | Devon and Cornwall | 85 | 4 | .. | 18 | 9.9 | 38 | 9.9 | 39 | 11.0 | 2 | .. |
| | | Greater Manchester | 66 | 2 | .. | 3 | .. | 39 | .. | 47 | 11.0 | 9 | 12.5 |
| | | Metropolitan | 76 | 1 | .. | 21 | 9.9 | 43 | 9.9 | 33 | 12.2 | 1 | .. |
| | Controls | Birmingham 3 | 53 | 6 | .. | 8 | .. | 30 | .. | 42 | 10.7 | 15 | 9.7 |
| | | North Petherton | 132 | 5 | 11.1 | 34 | 11.4 | 41 | 11.4 | 20 | 11.7 | 1 | - |
| Women | Exposed | Birmingham 1 | 58 | 21 | 9.0 | 19 | 10.5 | 45 | 9.0 | 14 | 12.3 | 2 | .. |
| | | Birmingham 2 | 53 | 17 | 9.3 | 36 | 10.0 | 26 | 9.9 | 15 | 9.0 | 6 | .. |
| | | Bristol | 99 | 7 | 7.5 | 20 | 7.1 | 49 | 8.8 | 23 | 8.6 | - | - |
| | | Liverpool | 54 | 20 | 8.1 | 35 | 11.0 | 22 | 12.3 | 22 | 11.7 | - | - |
| | | London - Brent | 37 | 32 | 7.9 | 27 | 7.6 | 35 | 8.1 | 5 | .. | - | - |
| | | - Lambeth | 14 | .. | .. | .. | .. | .. | .. | .. | .. | - | - |
| | | - Waltham Forest | 39 | 41 | 7.2 | 36 | 7.5 | 18 | 6.2 | 5 | .. | - | - |
| | | Manchester | 47 | 17 | 9.1 | 45 | 9.6 | 11 | .. | 21 | 11.7 | - | - |
| | | Sheffield | 63 | 14 | 7.6 | 27 | 7.9 | 32 | 7.4 | 25 | 8.8 | 2 | .. |
| | Police | Devon and Cornwall | 10 | .. | .. | .. | .. | .. | .. | .. | .. | - | - |
| | | Greater Manchester | 9 | .. | - | .. | .. | .. | .. | .. | .. | - | - |
| | | Metropolitan | 3 | - | - | .. | .. | - | - | .. | .. | - | - |
| | Controls | Birmingham 3 | 49 | 18 | 6.9 | 31 | 7.8 | 35 | 8.0 | 16 | 7.1 | - | - |
| | | North Petherton | 151 | 13 | 8.6 | 54 | 7.3 | 25 | 8.1 | 9 | 8.5 | - | - |

## Table 13 Blood Lead Concentration by Smoking and Drinking Habits, 1985

| | | Drinking | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Smoking | Teetotal | | Occasional | | Light | | Moderate | | Heavier | | Total | |
| | | % | GM | % | GM | % | GM | % | GM | % | GM | % | GM |
| Men | Non-smoker | 5 | 10.6 | 13 | 10.3 | 20 | 10.4 | 19 | 11.3 | 5 | 12.3 | 62 | 10.8 |
| | Pipe/cigar | .. | .. | 1 | (10.4) | 3 | 10.4 | 5 | 12.1 | .. | .. | 10 | 11.3 |
| | 1-20 cigarettes | 2 | (11.0) | 4 | 12.4 | 4 | 11.3 | 8 | 13.3 | 2 | 12.1 | 20 | 12.3 |
| | >20 cigarettes | 1 | .. | 1 | .. | 2 | (12.8) | 3 | 14.8 | 1 | (15.1) | 7 | 13.9 |
| | Total | 7 | 11.1 | 20 | 10.9 | 29 | 10.7 | 34 | 12.0 | 10 | 12.6 | 100 | 11.4 |
| Women | Non-smoker | 12 | 7.7 | 24 | 7.9 | 22 | 8.3 | 10 | 8.4 | .. | .. | 67 | 8.1 |
| | Pipe/cigar | .. | .. | .. | .. | .. | .. | – | – | – | – | .. | .. |
| | 1-20 cigarettes | 4 | 9.3 | 9 | 8.7 | 8 | 9.3 | 6 | 11.9 | 1 | (8.8) | 28 | 9.6 |
| | >20 cigarettes | .. | .. | 1 | (7.5) | 1 | (9.8) | .. | .. | .. | .. | 4 | (9.0) |
| | Total | 17 | 8.1 | 34 | 8.1 | 31 | 8.7 | 16 | 9.5 | 1 | (10.5) | 100 | 8.5 |

## Table 14 Blood Lead Concentration by Type of Drink - Children, 1985

173975 D

| (a) Milk | | N | Cereal | | | Tea | | | Milk | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yes | | No | Yes | | No | Yes | | No |
| | | | % | GM | GM | % | GM | GM | % | GM | GM |
| Exposed | Birmingham | 238 | **97** | 9.0 | 8.1 | **78** | 9.0 | 8.6 | **81** | 8.9 | 9.1 |
| | Bristol | 146 | **88** | 9.6 | 10.1 | **74** | 9.5 | 10.4 | **68** | 9.5 | 10.2 |
| | London - Bexley/Greenwich | 214 | **89** | 8.9 | 9.1 | **54** | 9.3 | 8.6 | **90** | 8.8 | 10.0 |
| | - Brent | 93 | **87** | 9.8 | 10.0 | **81** | 9.8 | 9.9 | **82** | 9.8 | 9.9 |
| | - Waltham Forest | 186 | **97** | 9.5 | 7.3 | **69** | 9.3 | 9.8 | **85** | 9.6 | 8.4 |
| | Sheffield | 111 | **86** | 8.4 | 11.0 | **61** | 9.4 | 7.8 | **85** | 9.0 | 7.7 |
| Controls | North Petherton | 10 | **100** | 7.4 | - | **100** | 7.4 | - | **80** | 7.4 | .. |

| (b) Other drinks | | N | Tap water | | | Bottled water | | | Canned drinks | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Yes | | No | Yes | | No | Yes | | No |
| | | | % | GM | GM | % | GM | GM | % | GM | GM |
| Exposed | Birmingham | 238 | **89** | 8.9 | 9.7 | **7** | 9.7 | 8.9 | **50** | 9.0 | 8.9 |
| | Bristol | 146 | **95** | 9.7 | .. | **3** | .. | 9.9 | **23** | 10.3 | 9.6 |
| | London - Bexley/Greenwich | 214 | **96** | 9.0 | 8.8 | **3** | 8.6 | 9.0 | **4** | 8.3 | 9.0 |
| | - Brent | 93 | **98** | 9.8 | .. | **5** | .. | 9.9 | **62** | 10.1 | 9.3 |
| | - Waltham Forest | 186 | **88** | 9.5 | 8.8 | **7** | 7.8 | 9.6 | **25** | 9.0 | 9.6 |
| | Sheffield | 111 | **91** | 8.7 | 9.6 | **2** | .. | 8.7 | **23** | 9.0 | 8.7 |
| Controls | North Petherton | 10 | **100** | 7.4 | - | - | - | 7.4 | **70** | 7.6 | .. |

# Table 15 Blood Lead Concentration by Age of Dwelling, 1985

| | | | N | Pre-1945 | | Post-1945 | | nk |
|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % |
| Men | Exposed | Birmingham 1 | 44 | 61 | 12.2 | 39 | 11.7 | - |
| | | Birmingham 2 | 48 | 98 | 12.5 | 2 | .. | - |
| | | Bristol | 90 | 99 | 11.6 | 1 | .. | - |
| | | Liverpool | 42 | 95 | 12.3 | 5 | .. | - |
| | | London - Brent | 25 | 96 | 11.2 | - | - | 4 |
| | | - Lambeth | 12 | .. | .. | .. | .. | - |
| | | - Waltham Forest | 45 | 78 | 10.7 | 22 | 9.4 | - |
| | | Manchester | 52 | 94 | 13.9 | 6 | .. | - |
| | | Sheffield | 48 | 94 | 11.9 | 6 | .. | - |
| | Police | Devon and Cornwall | 85 | 26 | 11.2 | 68 | 10.3 | 6 |
| | | Greater Manchester | 66 | 35 | 11.4 | 64 | 11.3 | 2 |
| | | Metropolitan | 76 | 54 | 11.3 | 43 | 11.5 | 3 |
| | Controls | Birmingham 3 | 53 | 26 | 10.4 | 74 | 9.9 | - |
| | | North Petherton | 132 | 51 | 11.2 | 49 | 10.2 | - |
| Women | Exposed | Birmingham 1 | 58 | 59 | 9.1 | 41 | 10.3 | - |
| | | Birmingham 2 | 53 | 94 | 9.7 | 6 | 11.1 | - |
| | | Bristol | 99 | 98 | 8.3 | 2 | .. | - |
| | | Liverpool | 54 | 98 | 10.8 | 2 | .. | - |
| | | London - Brent | 37 | 100 | 8.0 | - | - | - |
| | | - Lambeth | 14 | 57 | 10.1 | 43 | 8.5 | - |
| | | - Waltham Forest | 39 | 79 | 7.1 | 21 | 7.6 | - |
| | | Manchester | 47 | 96 | 10.2 | 4 | .. | - |
| | | Sheffield | 63 | 90 | 7.7 | 10 | 10.3 | - |
| | Police | Devon and Cornwall | 10 | .. | .. | .. | .. | - |
| | | Greater Manchester | 9 | .. | .. | .. | .. | - |
| | | Metropolitan | 3 | .. | .. | .. | .. | - |
| | Controls | Birmingham 3 | 49 | 22 | 9.0 | 78 | 7.2 | - |
| | | North Petherton | 151 | 47 | 8.8 | 53 | 6.9 | - |

/continued

## Table 15 Blood Lead Concentration by Age of Dwelling, 1985 (contd)

| | | | N | Pre-1945 | | Post-1945 | | nk |
|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % |
| Children | Exposed | Birmingham | 238 | 63 | 9.9 | 33 | 7.4 | 4 |
| | | Bristol | 146 | 65 | 10.1 | 25 | 8.5 | 10 |
| | | London - Bexley/Greenwich | 214 | 29 | 9.2 | 70 | 8.7 | 1 |
| | | - Brent | 93 | 75 | 10.2 | 25 | 8.8 | - |
| | | - Waltham Forest | 186 | 72 | 9.6 | 28 | 9.1 | - |
| | | Sheffield | 111 | 69 | 9.1 | 31 | 8.1 | - |
| | Controls | North Petherton | 10 | 80 | 7.5 | 20 | .. | - |

## Table 16 Blood Lead Concentration by Length of Residence, 1985

| | | | N | 0-5 years | | 6-10 years | | 11-15 years | | 16-20 years | | Over 20 years | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | % | GM | % | GM | % | GM | % | GM | % | GM |
| Men | Exposed | Birmingham 1 | 44 | 27 | 11.7 | 18 | 14.6 | 11 | .. | 9 | .. | 34 | 11.1 |
| | | Birmingham 2 | 48 | 21 | 12.7 | 23 | 11.3 | 8 | .. | 15 | 12.2 | 33 | 13.8 |
| | | Bristol | 90 | 26 | 10.8 | 40 | 12.0 | 12 | 10.1 | 10 | 11.5 | 12 | 14.1 |
| | | Liverpool | 42 | 14 | 9.6 | 29 | 11.8 | 12 | .. | 19 | 13.8 | 26 | 12.6 |
| | | London - Brent | 25 | 24 | 10.7 | 20 | .. | 8 | .. | 16 | .. | 32 | 10.9 |
| | | - Lambeth | 12 | .. | .. | .. | .. | .. | .. | - | - | .. | .. |
| | | - Waltham Forest | 45 | 11 | .. | 24 | 10.9 | 13 | 10.7 | 16 | 10.2 | 36 | 10.3 |
| | | Manchester | 52 | 6 | .. | 15 | 13.2 | 29 | 14.0 | 15 | 15.9 | 35 | 13.3 |
| | | Sheffield | 48 | 35 | 13.0 | 19 | 10.4 | 8 | .. | 15 | 10.9 | 23 | 13.3 |
| | Police | Devon and Cornwall | 85 | 65 | 10.5 | 20 | 10.0 | 7 | 9.8 | 7 | 12.1 | 1 | .. |
| | | Greater Manchester | 66 | 68 | 11.6 | 14 | 10.6 | 9 | 13.0 | 5 | .. | 5 | .. |
| | | Metropolitan | 76 | 58 | 11.6 | 21 | 10.4 | 9 | 12.0 | 9 | 10.6 | 3 | .. |
| | Controls | Birmingham 3 | 53 | 26 | 9.9 | 33 | 9.7 | 19 | 10.1 | 11 | 10.8 | 21 | 10.1 |
| | | North Petherton | 132 | 34 | 10.4 | 18 | 10.7 | 11 | 11.2 | 11 | 9.6 | 24 | 11.5 |
| Women | Exposed | Birmingham 1 | 58 | 24 | 9.4 | 17 | 8.0 | 7 | .. | 19 | 11.3 | 33 | 9.8 |
| | | Birmingham 2 | 53 | 23 | 9.9 | 23 | 8.6 | 8 | .. | 13 | 8.0 | 34 | 11.9 |
| | | Bristol | 99 | 33 | 8.0 | 38 | 7.6 | 8 | 9.0 | 11 | 9.4 | 9 | 10.7 |
| | | Liverpool | 54 | 9 | .. | 30 | 10.6 | 19 | 9.7 | 13 | 8.6 | 30 | 12.6 |
| | | London - Brent | 37 | 19 | 6.8 | 24 | 9.3 | 8 | .. | 11 | .. | 38 | 8.4 |
| | | - Lambeth | 14 | .. | .. | .. | .. | .. | .. | - | - | .. | .. |
| | | - Waltham Forest | 39 | 18 | 6.4 | 18 | 8.4 | 13 | .. | 15 | 6.3 | 36 | 7.9 |
| | | Manchester | 47 | 19 | 9.5 | 23 | 9.4 | 17 | 9.3 | 15 | 11.1 | 26 | 12.0 |
| | | Sheffield | 63 | 37 | 7.8 | 24 | 6.6 | 8 | .. | 13 | 8.2 | 19 | 9.1 |
| | Police | Devon and Cornwall | 10 | .. | .. | .. | .. | - | - | - | - | - | - |
| | | Greater Manchester | 9 | .. | .. | - | - | .. | .. | - | - | .. | .. |
| | | Metropolitan | 3 | .. | .. | - | - | - | - | - | - | - | - |
| | Controls | Birmingham 3 | 49 | 29 | 7.1 | 18 | 7.3 | 18 | 7.1 | 20 | 8.5 | 14 | 8.4 |
| | | North Petherton | 151 | 28 | 7.4 | 21 | 7.0 | 11 | 8.3 | 14 | 7.7 | 26 | 8.6 |

## Table 17 Blood Lead Concentration in Children by Exposure of Adult in Household to Lead; Age; Residence since Birth; and Siblings - 1985

| | | | N | (a) Adult in household exposed to lead | | | (b) Age | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Yes | | No | 6 and under | | 7 & over |
| | | | | % | GM | GM | % | GM | GM |
| Children | Exposed | Birmingham | 238 | **16** | 8.9 | 8.9 | **18** | 8.9 | 8.9 |
| | | Bristol | 146 | **30** | 10.2 | 9.4 | **25** | 9.0 | 9.8 |
| | | London - Bexley/Greenwich | 214 | **29** | 9.5 | 8.7 | **88** | 9.0 | 8.8 |
| | | - Brent | 93 | **26** | 9.9 | 9.8 | **65** | 9.9 | 9.7 |
| | | - Waltham Forest | 186 | **22** | 9.5 | 9.4 | **90** | 9.6 | 8.5 |
| | | Sheffield | 111 | **13** | 9.2 | 8.7 | **27** | 9.7 | 8.4 |
| | Controls | North Petherton | 10 | **20** | .. | 7.7 | **20** | .. | 7.4 |

| | | | N | (c) Resident since Birth | | | (d) Siblings | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Yes | | No | Yes | | No |
| | | | | % | GM | GM | % | GM | GM |
| Children | Exposed | Birmingham | 238 | **38** | 8.5 | 9.2 | **91** | 9.0 | 8.0 |
| | | Bristol | 146 | **45** | 9.4 | 9.8 | **91** | 9.5 | 11.3 |
| | | London - Bexley/Greenwich | 214 | **26** | 9.0 | 8.9 | **93** | 9.0 | 8.0 |
| | | - Brent | 93 | **30** | 9.6 | 9.9 | **88** | 9.9 | 8.9 |
| | | - Waltham Forest | 186 | **47** | 9.5 | 9.4 | **91** | 9.5 | 8.9 |
| | | Sheffield | 111 | **26** | 8.8 | 8.7 | **96** | 8.7 | 9.0 |
| | Controls | North Petherton | 10 | **50** | .. | .. | **80** | 7.3 | .. |

## Table 18 Blood Lead Concentration by Socio-economic Factors*, 1985

| Factor | | Men | | Women | | Children | |
|---|---|---|---|---|---|---|---|
| | | % | GM | % | GM | % | GM |
| Social Class | I and II | 24 | 11.1 | 20 | 9.0 | 24 | 8.9 |
| | III non-manual | 34 | 11.5 | 47 | 8.4 | 13 | 8.7 |
| | III manual | 30 | 11.8 | 10 | 8.5 | 42 | 9.3 |
| | IV and V | 11 | 10.9 | 17 | 8.2 | 18 | 9.2 |
| | Other | 2 | (9.7) | 6 | 8.8 | 4 | (10.5) |
| Ethnic Origin | White | 97 | 11.4 | 97 | 8.5 | 80 | 9.3 |
| | African/West Indian | 3 | (11.4) | 3 | (9.1) | 7 | 7.9 |
| | Ind/Pak/Bangl | | | | | 11 | 9.2 |
| | Other | | | | | 2 | (8.2) |
| Smoking Habits | Non-smoker | 62 | 10.9 | 67 | 8.1 | | |
| | 1-20 cigarettes/day | 20 | 12.2 | 28 | 9.5 | | |
| | >20 cigarettes/day | 7 | 13.4 | 4 | (9.0) | | |
| | Cigar/pipe | 10 | 11.3 | .. | .. | | |
| Drinking Habits | Teetotal | 8 | 10.6 | 17 | 8.5 | | |
| | Occasional | 20 | 10.7 | 34 | 8.0 | | |
| | Light | 29 | 10.9 | 31 | 8.9 | | |
| | Moderate | 34 | 12.1 | 16 | 9.7 | | |
| | Heavier | 10 | 12.5 | 1 | (9.5) | | |
| Age of Dwelling | Pre-1945 | 65 | 11.7 | 73 | 8.7 | 61 | 9.7 |
| | Post-1945 | 35 | 10.9 | 27 | 8.1 | 39 | 8.4 |
| Length of Residence | Up to 5 years | 35 | 11.4 | 28 | 8.5 | | |
| | 6-10 years | 23 | 11.0 | 24 | 8.2 | | |
| | 11-15 years | 12 | 11.3 | 11 | 8.2 | | |
| | 16-20 years | 11 | 11.7 | 13 | 8.9 | | |
| | Over 20 years | 19 | 11.6 | 24 | 8.9 | | |
| Exposure to lead** | Yes | 41 | 11.6 | 5 | (8.8) | 22 | 9.3 |
| | No | 59 | 11.2 | 95 | 8.5 | 78 | 9.1 |

* Results from multiple regression analyses; based on 808 men, 686 women and 973 children.

** For adults, "occupational" exposure; for children, exposure to lead of adult in household.

## Table 19 Blood Lead Concentration by Geographical Location*, 1985

| Survey | | Men | | Women | | Ratio of GMs in men & women | Children# | |
|---|---|---|---|---|---|---|---|---|
| | | N | GM | N | GM | | N | GM |
| Exposed | Birmingham 1 | 44 | 11.4 | 58 | 9.2 | 1.25 | 229 | 9.0 |
| | Birmingham 2 | 48 | 11.8 | 53 | 9.6 | 1.23 | | |
| | Bristol | 90 | 11.5 | 99 | 8.3 | 1.38 | 132 | 9.4 |
| | Liverpool | 42 | 11.6 | 54 | 10.0 | 1.15 | - | - |
| | London - Bexley/Greenwich | - | - | - | - | - | 212 | 9.2 |
| | - Brent | 24 | 11.0 | 37 | 7.7 | 1.42 | 93 | 10.1 |
| | - Lambeth | 12 | .. | 14 | .. | (1.25) | - | - |
| | - Waltham Forest | 45 | 10.5 | 39 | 7.3 | 1.44 | 186 | 9.2 |
| | Manchester | 52 | 12.9 | 47 | 10.2 | 1.27 | - | - |
| | Sheffield | 48 | 11.2 | 63 | 7.8 | 1.45 | 111 | 8.6 |
| Police | Devon and Cornwall | 80 | 11.1 | 10 | .. | .. | - | - |
| | Greater Manchester | 65 | 12.8 | 9 | .. | .. | - | - |
| | Metropolitan | 74 | 10.4 | 3 | .. | .. | - | - |
| Controls | Birmingham 3 | 53 | 10.3 | 49 | 8.0 | 1.28 | - | - |
| | North Petherton | 131 | 11.1 | 151 | 8.0 | 1.39 | 10 | .. |
| Total | | 808 | 11.4 | 686 | 8.5 | 1.33 | 973 | 9.2 |

* Results from multiple regression analyses; based on 808 men, 686 women and 973 children.

# Surveys of children not in same areas as surveys of adults living on major roads.

## Table 20 Numbers of Participants 1984 and 1985, and % Follow-up*

| | | Men | | | Women | | | Children | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1984 | 1985 | % follow-up | 1984 | 1985 | % follow-up | 1984 | 1985 |
| Exposed | Birmingham 1 | 42 | 44 | **67** | 54 | 58 | **70** | 247 | 238 |
| | Birmingham 2 | 48 | 48 | **65** | 53 | 53 | **58** | | |
| | Bristol | 97 | 90 | **78** | 104 | 99 | **82** | 116 | 146 |
| | Liverpool | 44 | 42 | **77** | 54 | 54 | **81** | – | – |
| | London – Bexley/Greenwich | – | – | – | – | – | – | 228 | 214 |
| | Brent | – | 25 | – | – | 37 | – | – | 93 |
| | Lambeth | – | 12 | – | – | 14 | – | – | – |
| | Waltham Forest | 52 | 45 | **67** | 54 | 39 | **61** | 200 | 186 |
| | Manchester | 54 | 52 | **94** | 47 | 47 | **96** | 31 | – |
| | Sheffield | 47 | 48 | **91** | 67 | 63 | **90** | 108 | 111 |
| | | 384 | 406 | **78** | 433 | 464 | **78** | 930 | 988 |
| Police | Devon & Cornwall | – | 85 | – | – | 10 | – | | |
| | Greater Manchester | 63 | 66 | **73** | 11 | 9 | .. | | |
| | Metropolitan | 109 | 76 | **56** | 4 | 3 | .. | | |
| | | 172 | 227 | **62** | 15 | 22 | .. | | |
| Controls | Birmingham 3 | 51 | 53 | **73** | 53 | 49 | **70** | – | – |
| | North Petherton | 141 | 132 | **85** | 157 | 151 | **85** | 15 | 10 |
| | | 192 | 185 | **82** | 210 | 200 | **81** | 15 | 10 |
| Total | | 748 | 818 | | 658 | 686 | | 945 | 998 |
| Over 25 μg/100ml | | 21 | 11 | | 3 | 4 | | 7 | 9 |
| Grand Total | | 769 | 829 | | 661 | 690 | | 952 | 1007 |

* Excluding those over 25 μg/100ml in either year.

## Table 21 Changes in Geometric Mean[a] Blood Lead[b] from 1984 to 1985

| Group | Survey | Adults | | | | | | Children | |
|---|---|---|---|---|---|---|---|---|---|
| | | Men | | | Women | | | | |
| | | PbB | % | | PbB | % | | PbB | % |
| Exposed | Birmingham 1 | -0.9 | -7 | | -0.8 | -8 | | 1.2 | -11 |
| | Birmingham 2 | -0.4 | -4 | ns | -0.1 | -1 | ns | | |
| | Bristol | -1.3 | -10 | | -1.0 | -11 | | +0.6 | +7 |
| | Liverpool | -1.3 | -9 | | -0.6 | -5 | ns | | – |
| | London – Bexley/Greenwich | – | – | | – | – | | -2.1 | -19 |
| | Brent | x | x | | x | | | x | |
| | Lambeth | x | x | | x | | | – | – |
| | Waltham Forest | -1.0 | -9 | | -1.0 | -12 | | -0.1 | -1 |
| | Manchester | +0 | +0 | | -0.8 | -7 | | 9 | |
| | Sheffield | -0.4 | -3 | ns | -1.1 | -14 | | -0.9 | -10 |
| | | -0.8 | -6.3 | | -0.9 | -9.1 | | -0.8 | -8.5 |
| Police | Devon & Cornwall | x | x | | x | | | | |
| | Greater Manchester | -1.0 | -8 | | .. | .. | | | |
| | Metropolitan | +0.8 | +7 | | .. | .. | | | |
| | | +0.1 | +0.5 | ns | .. | .. | | | |
| Controls | Birmingham 3 | -1.0 | -10 | | -0.9 | -9 | | – | – |
| | North Petherton | -0.4 | -4 | | -0 | -0 | ns | .. | .. |
| | | -0.6 | -5.3 | | -0.2 | -2.4 | ns | .. | .. |

a For adults, GMs of those sampled in both years; for children, GMs of all those sampled in each year adjusted for age of dwelling, etc.
b Excluding those over 25 µg/100ml in either year.
x No survey in 1984.
y No survey in 1985.
.. Very small number of participants – no result given.
ns Not statistically significant at the 5% level (see paragraph 5.6).

**Table 22 Average Airborne Lead Concentrations January-March 1984, 1985 and 1986**

| Survey Area | Sampling Period | Site | Lead Concentration ($ng\ m^{-3}$) 1984 | 1985 | 1986 | Per Cent Change 1985 to 1986 |
|---|---|---|---|---|---|---|
| Lead in Petrol | Monthly | Eskdalemuir | | 20 | 10 | -50 |
| | Weekly | Cottered | 130 | 130 | 100 | -23 |
| | | North Tyneside | | 270 | 150 | -44 |
| | | Hitchin | 560 | 530 | 330 | -38 |
| | | Cardiff | | 1370 | 780 | -43 |
| | | Manchester | | 2130 | 1070 | -50 |
| Multi-Element | Monthly | Motherwell | 260 | (540) | 330 | -39 |
| | | Leeds | 300 | 300 | 210 | -30 |
| | | Glasgow | 280 | 420 | 150 | -64 |
| | | Brent | 570 | 590 | 370 | -37 |
| | | Victoria | 410 | 640 | 280 | -56 |
| Continuous Monitoring | Weekly | Cromwell Road | 1380 | 1670 | 800 | -52 |
| London Scientific Services | Monthly | County Hall | 480 | 470 | 240 | -49 |
| Harwell | Quarterly | Chilton | 81 | 150 | 38 | -75 |
| | | Styrrup | 150 | 180 | 58 | -68 |
| | | Trebanos | 130 | 73 | 39 | -47 |
| | | Plynlimon | 40 | 37 | 15 | -59 |
| Average (17 sites) | | | | 560 | 290 | -49 |

Source: G McInnes, "Airborne Lead Concentrations and the Effect of Reductions in the Lead Content of Petrol", LR 587 (AP) M. Warren Spring Laboratory, 1986.

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## NOTES TO FIGURES

Figure 1 - shows the locations and types of survey.

Figures 2 to 4 - illustrate aspects of the quality assurance of the blood lead analysis described in Chapter 2. As the laboratory works in SI units, µmol $l^{-1}$, but reports the results in the conventional units, µg/100ml, both have been used as appropriate. The conversion factors between them are: 1 µmol $l^{-1}$ = 20.72 µg/100ml; and 1 µg/100ml = 0.0483 µmol $l^{-1}$.

Figure 5 - shows the blood lead distributions by survey for 1984 in "box plot" form.

Figure 6 - contain the frequency distributions of blood lead concentrations for the major groups of people sampled. The concentration of 25 µg/100ml is highlighted because the DHSS advise that where a person - particularly a child - is confirmed as having a blood lead level over 25 µg/100ml, his or her environment should be investigated for sources of lead and steps taken to reduce exposure [paragraph 5 of Circular 22/82 (67)].

Figure 7 - shows the blood lead distributions by survey for 1985 in "box plot" form.

Figure 8 - shows average blood lead concentrations by drinking category (the QF index - see Chapter 1 and Table 12) within smoking category (see Table 11). These averages (given in Table 13) have not been corrected for other socio-economic factors, eg age, which are known to be related to blood lead concentrations. It should be noted that the vertical scale is "broken" and does not start at zero.

Figures 9 and 10 - present some of the results for both 1984 and 1985 from the multiple regression analyses (see Chapters 3 and 4), ie they have been corrected for other factors, eg smoking habits and age of dwelling. The vertical scales in Figures 9 and 10 are "broken" and do not start at zero.

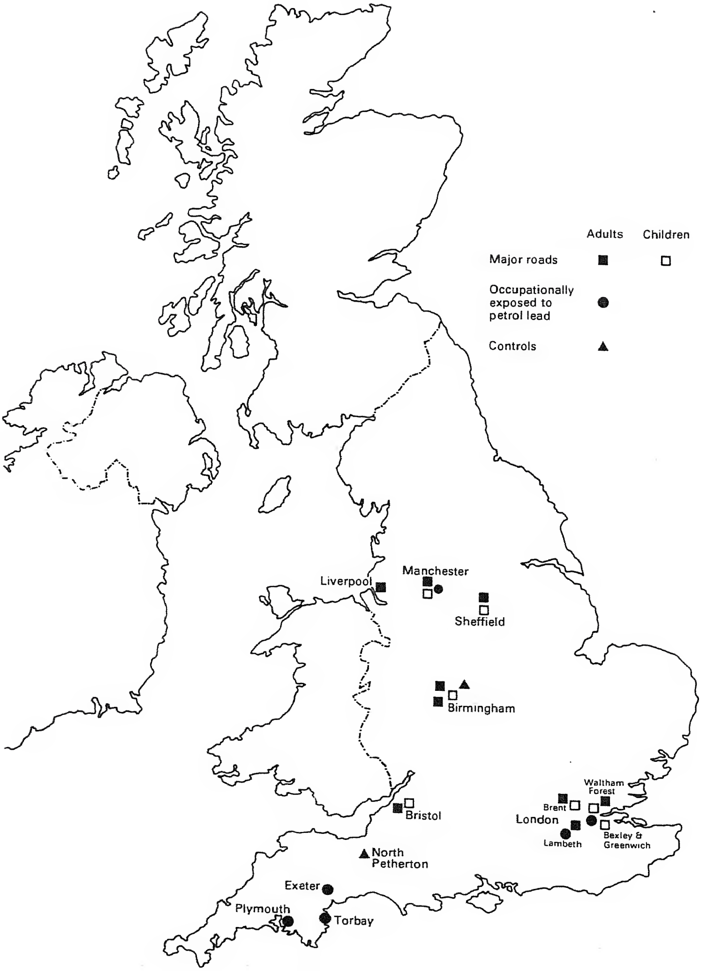
Figures 11 and 12 - illustrate, in "box plot" form, the distributions of blood lead concentrations in 1984 and 1985 in the major groups sampled and in the separate surveys of adults.

Figures 13 and 14 - present results for those adults sampled in both 1984 and 1985. Figure 13 shows histograms of the ratios of blood lead concentrations in the two years for the major groups sampled, whilst Figures 14(a) to (m) are scatterplots of the serial blood lead values for each of the separate surveys.

Figure 15 - illustrates, in "box plot" form, the distributions of blood lead concentrations in 1984 and 1985 in the separate surveys of children.

Figure 1

Locations of surveys



# Distributions of observed differences in blood lead concentrations between MSF-ASS and ETA-AAS

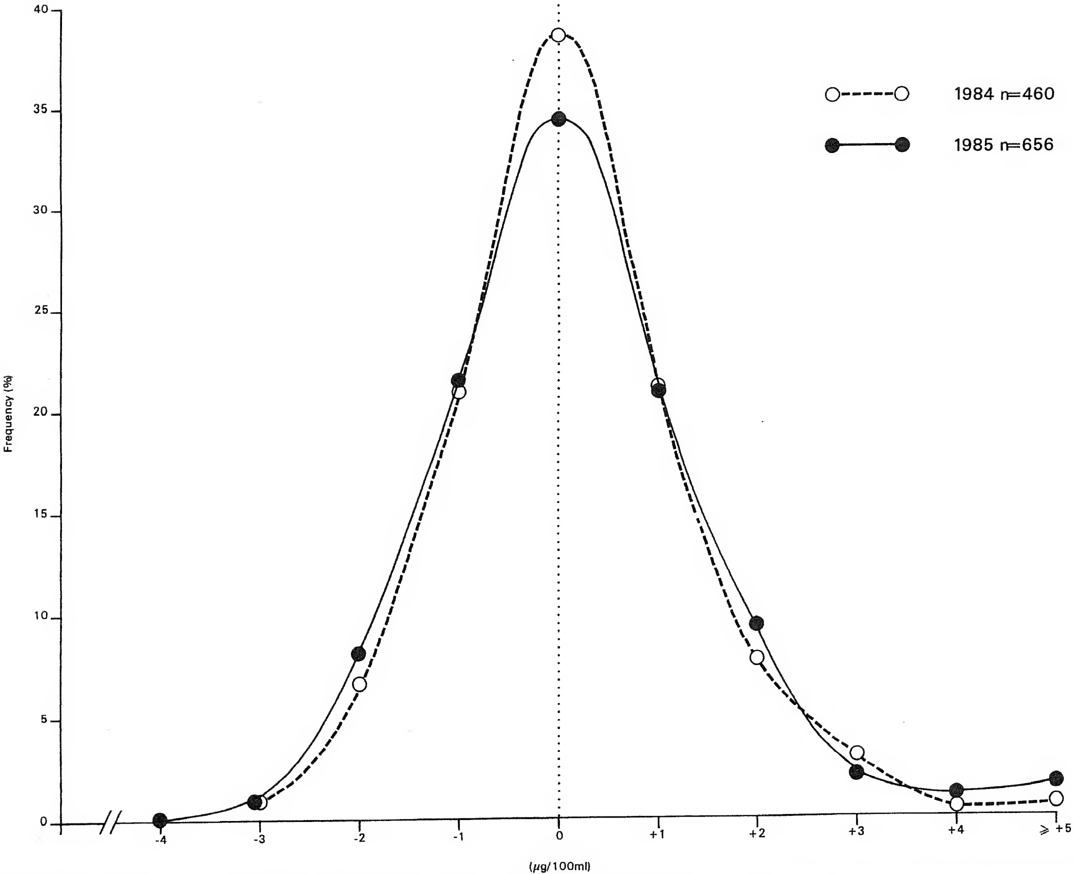
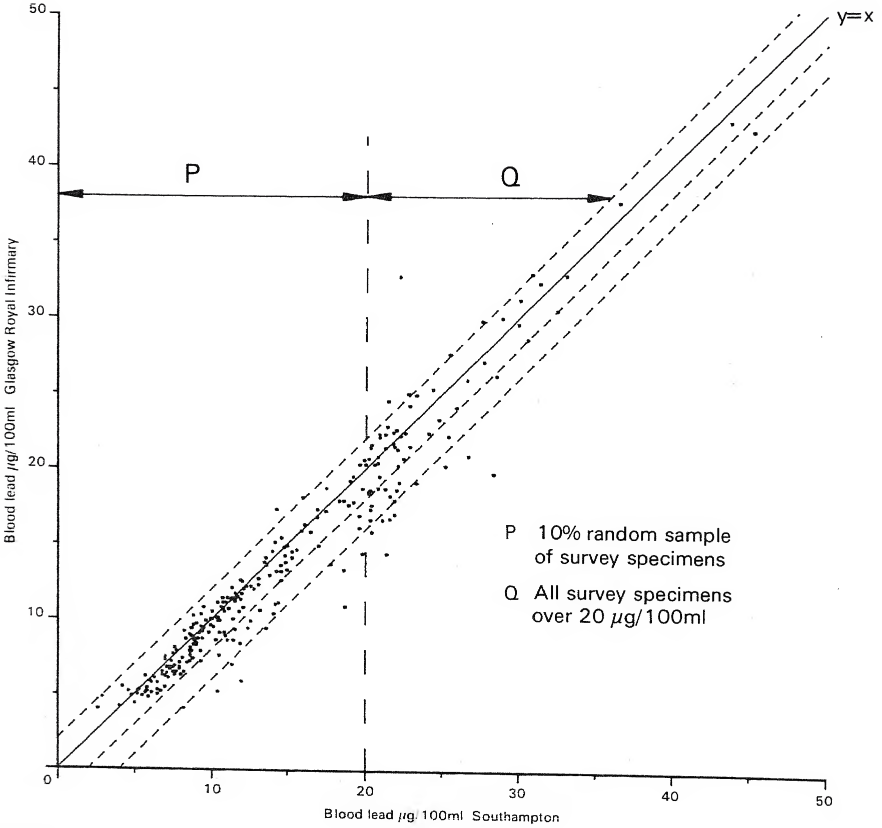


Figure 3

## Between laboratory re-analysis of 1985 survey specimens



Notes

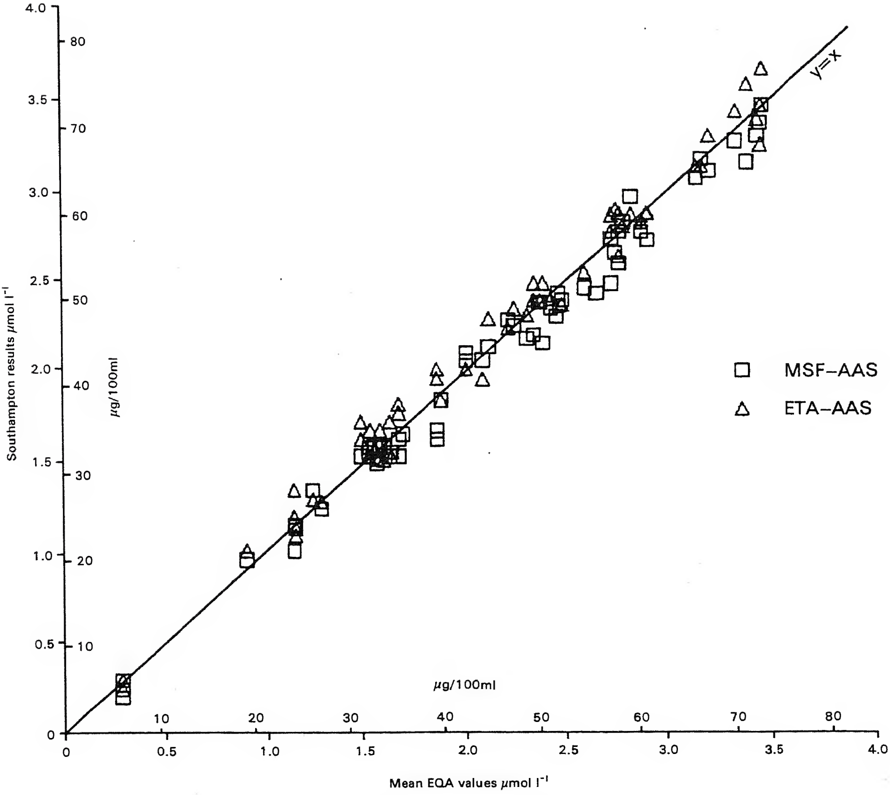
Above data are for 261 specimens from twelve survey areas (ie excluding samples from Bexley/Greenwich).

240 (92%) of repeat analyses gave differences in blood lead concentrations from +2 to -4 µg/100ml (Glasgow Royal Infirmary - Southampton).

Mean bias between laboratories was 1.0 µg/100ml (Southampton higher).

Figure 4

## Comparison of Southampton with mean EQA values
## (June 1985 – January 1987)



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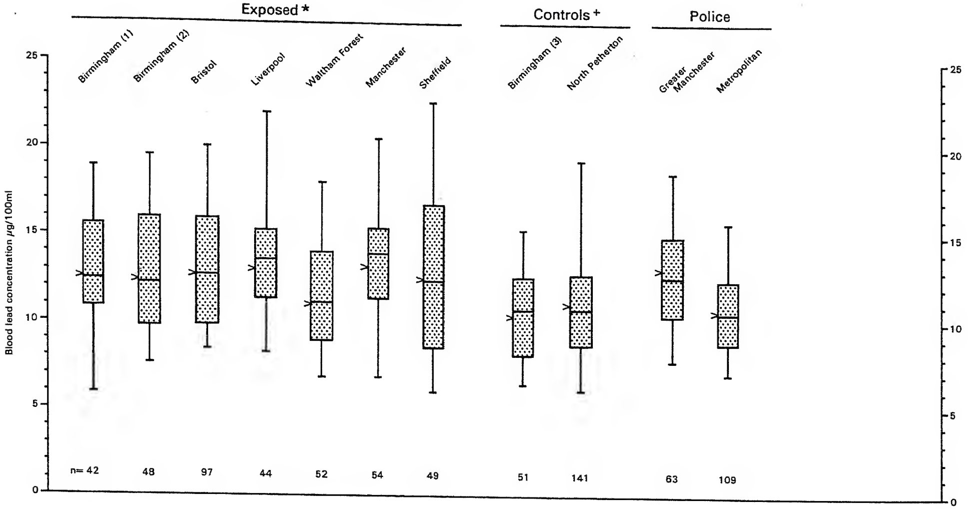
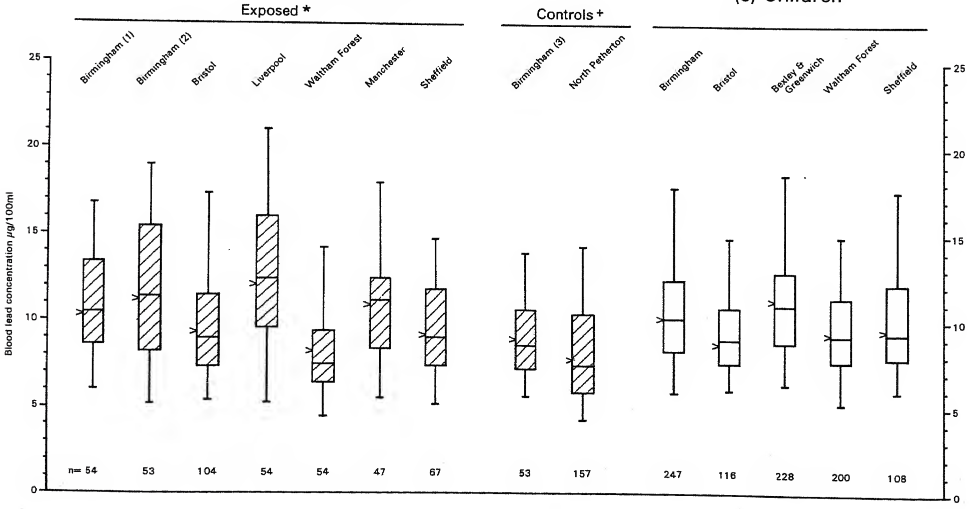
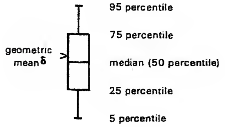
Distributions of blood lead concentrations, by survey 1984

(a) Men




(b) Women

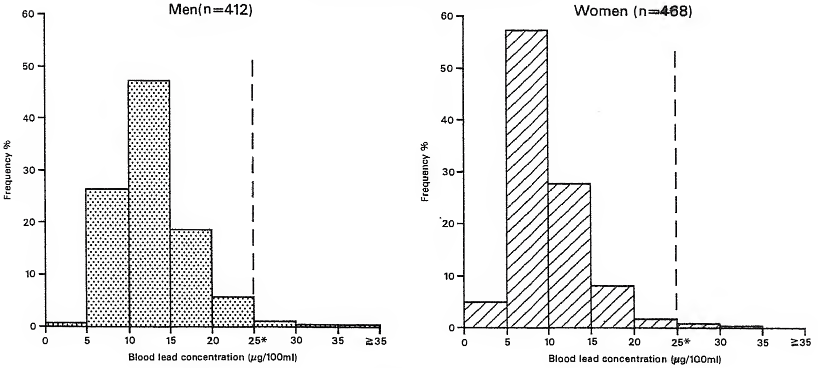
(c) Children ‡



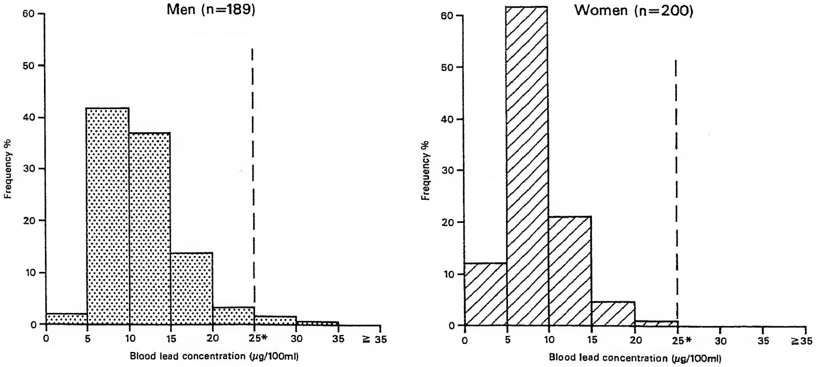
- ★ Adults living in houses fronting heavily trafficked urban roads
- + Adults living in areas where exposure to lead from petrol was low
- ‡ The surveys of children took place in different areas from those of adults
- δ Adjusted for age, smoking and drinking habits, etc.

## Distributions of blood lead concentrations 1985

(a) Adults living on major roads

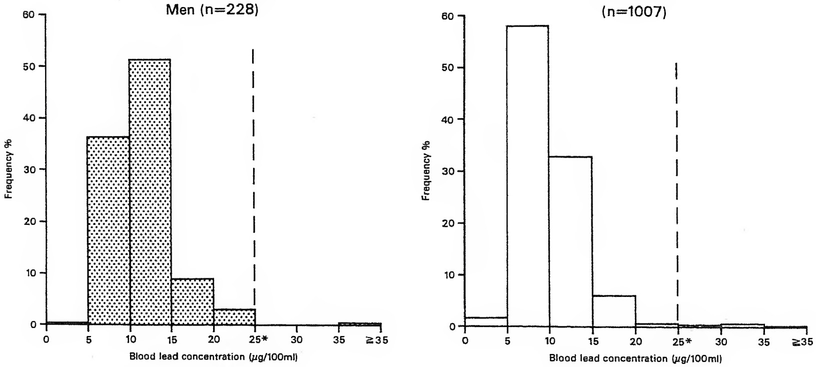


(b) Adult controls



(c) Police Officers

(d) Children

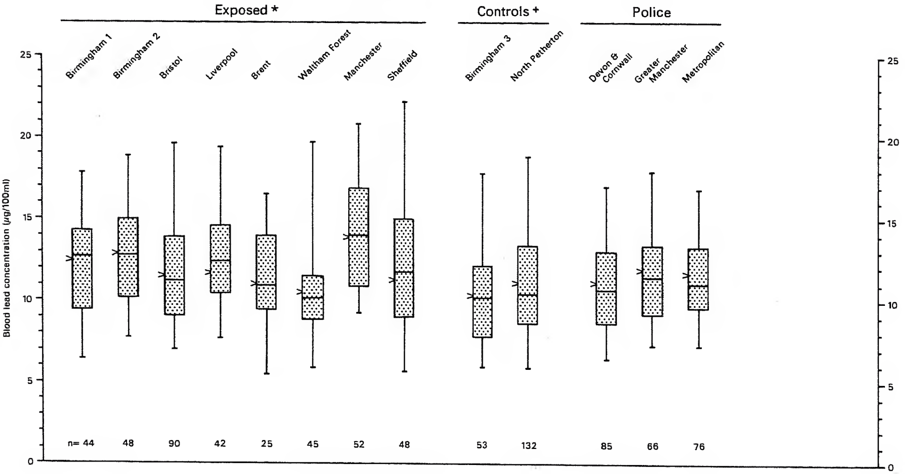


*DHSS advisory action limit

Figure 7

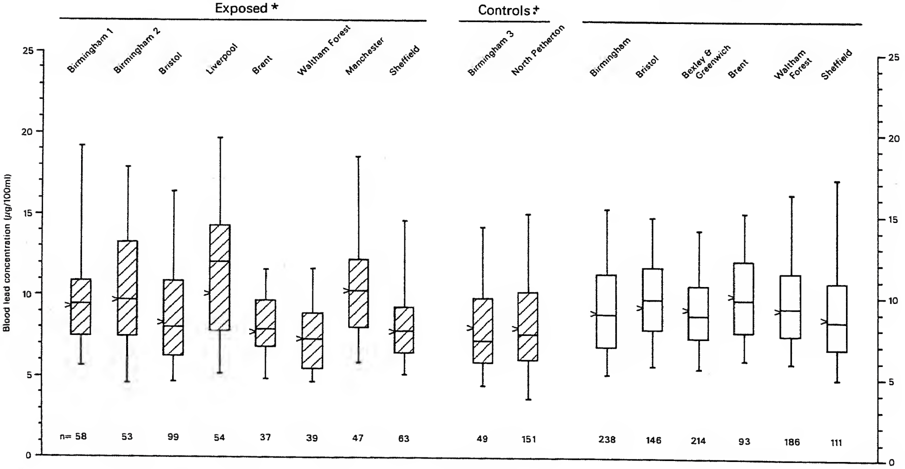
## Distributions of blood lead concentrations by survey, 1985

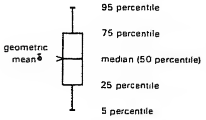
(a) Men



(b) Women

(c) Children ‡





* Adults living in houses fronting heavily trafficked urban roads

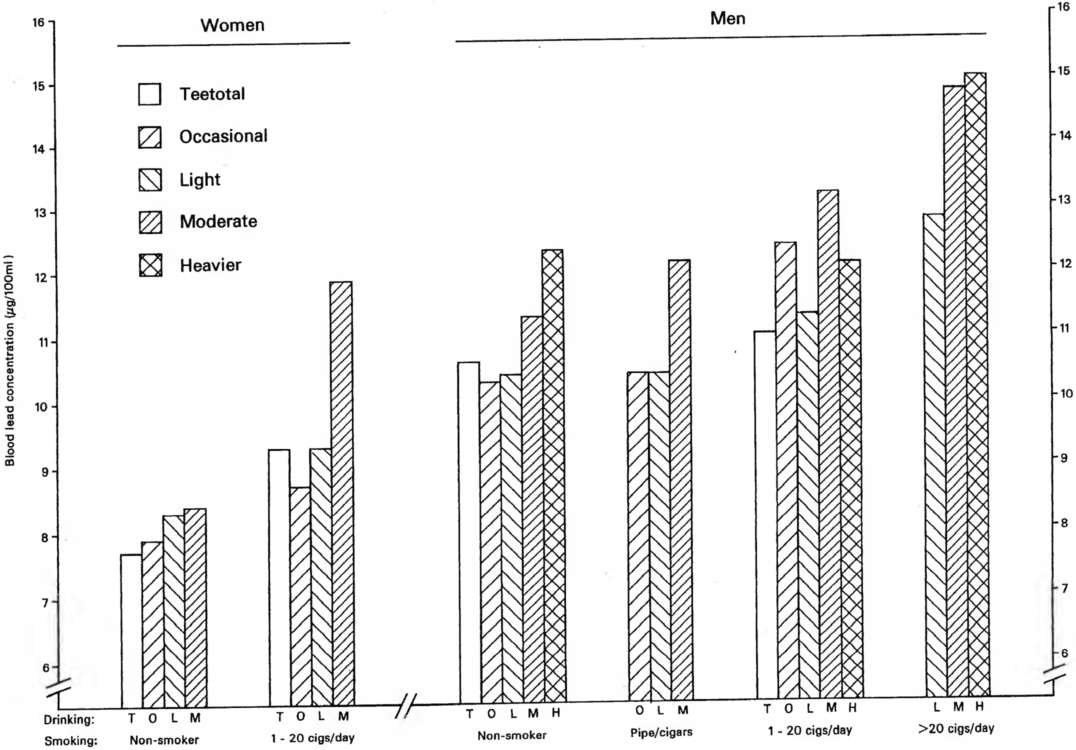
+ Adults living in areas where exposure to lead from petrol was low

‡ The surveys of children took place in different areas from those of adults

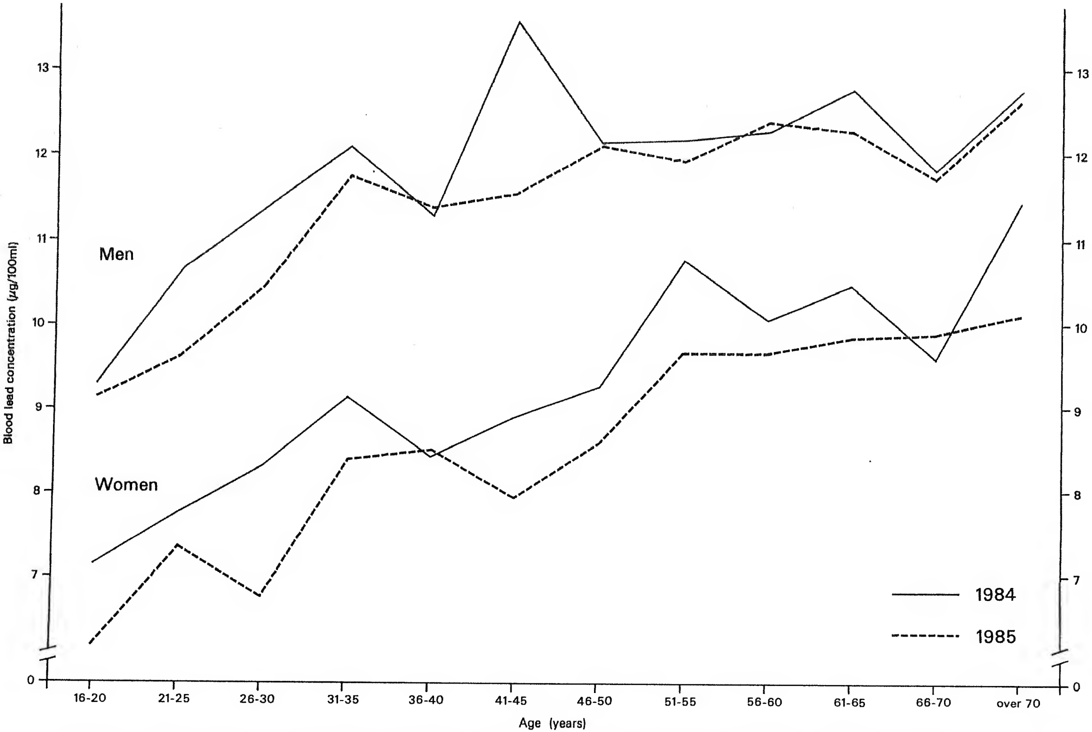
δ Adjusted for age, smoking and drinking habits, etc.

Figure 8

Blood lead concentration by smoking and drinking habits, 1985



# Blood lead concentrations in adults by age and sex, 1984 and 1985

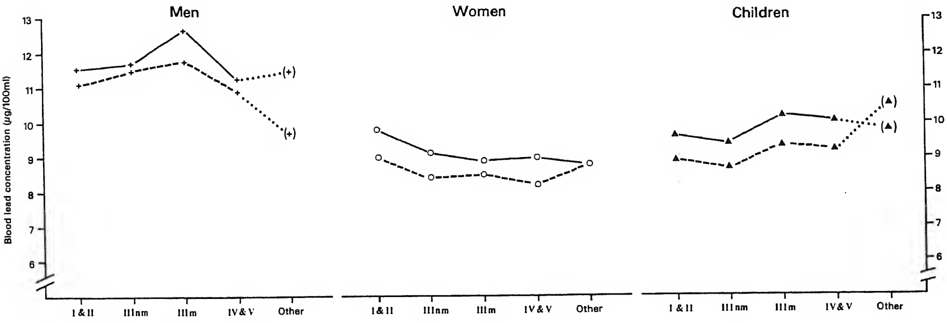


Results based on 745 men and 656 women in 1984, and 808 men and 686 women in 1985. In each year there were broadly similar numbers in each age category.

Figure 10

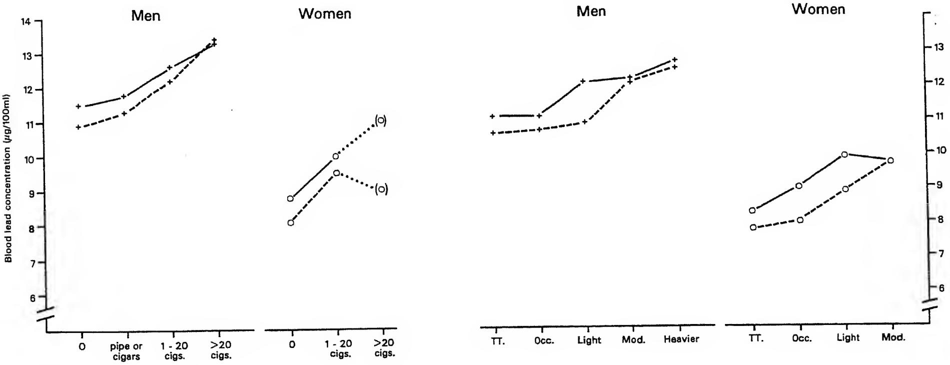
## Factors related to blood lead concentrations, 1984 and 1985

### (a) Social class



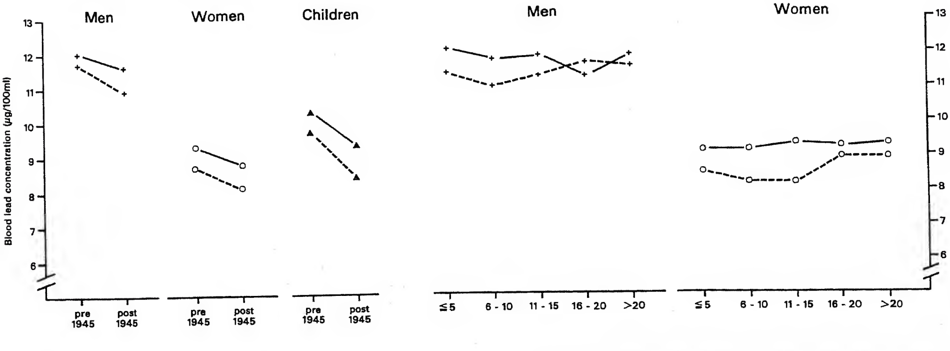
### (b) Smoking habits

### (c) Drinking habits



### (d) Age of dwelling

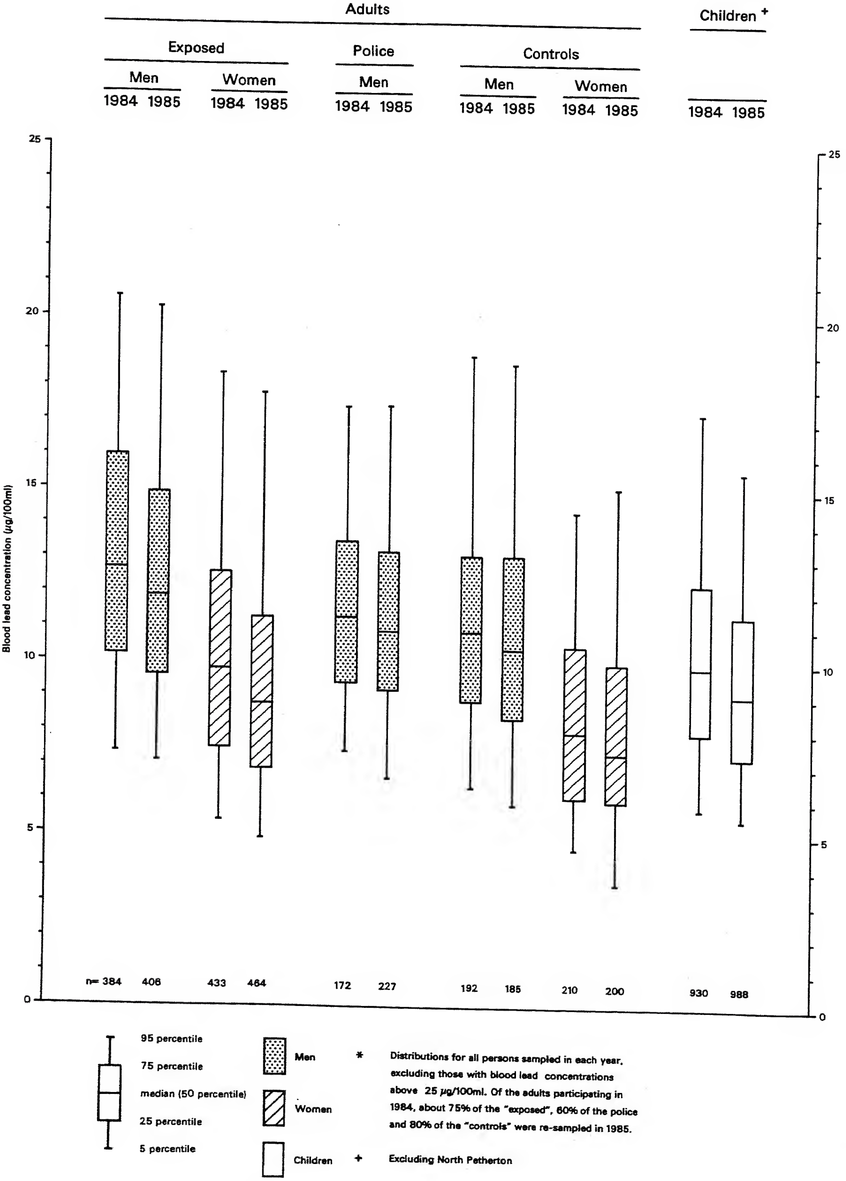
### (e) Length of residence



The proportions of participants in the various categories for 1985 are given in Table 18

## Figure 11

# Distributions* of blood lead concentrations, 1984 and 1985



* Distributions for all persons sampled in each year, excluding those with blood lead concentrations above 25 µg/100ml. Of the adults participating in 1984, about 75% of the "exposed", 60% of the police and 80% of the "controls" were re-sampled in 1985.

+ Excluding North Petherton

Figure 12(a)

Distribution of blood lead concentrations, 1984 and 1985

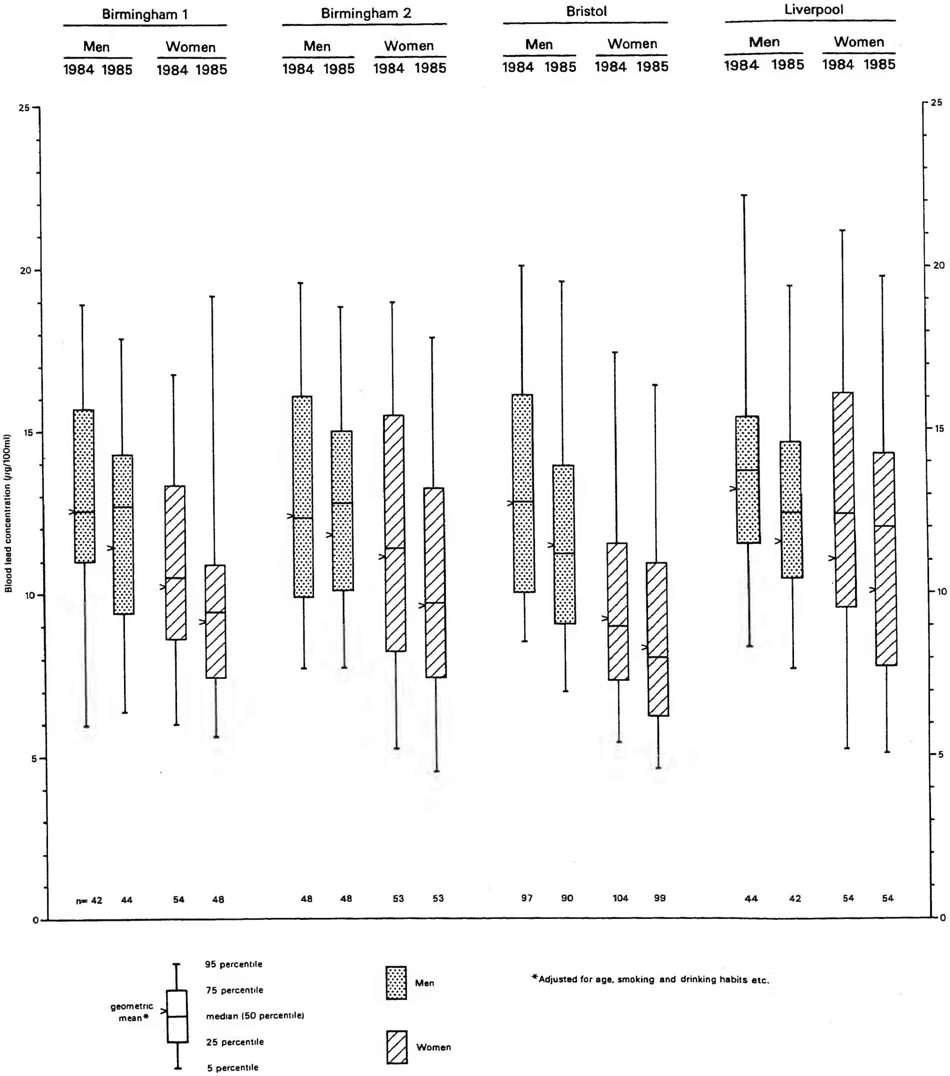


Figure 12 (b)

Disribution of blood lead concentrations, 1984 and 1985

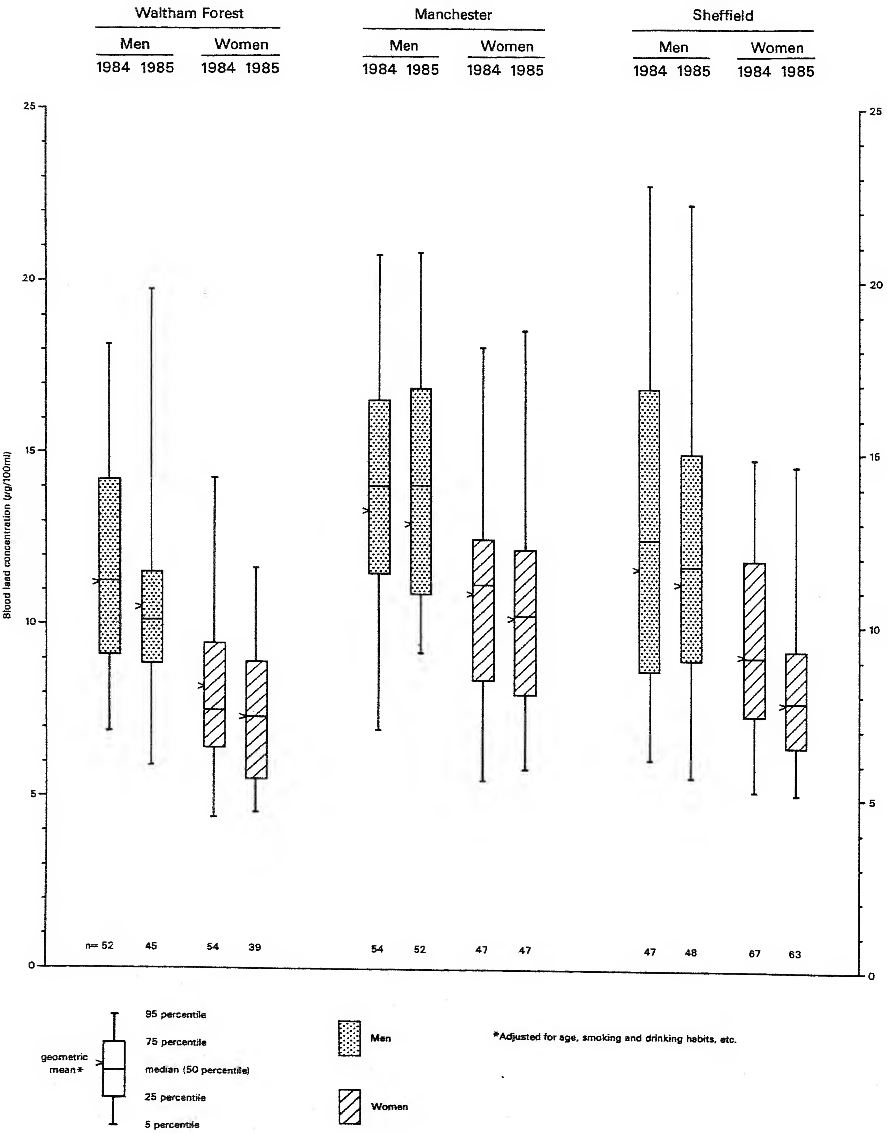


Figure 12 (c)

Distribution of blood lead concentrations, 1984 and 1985

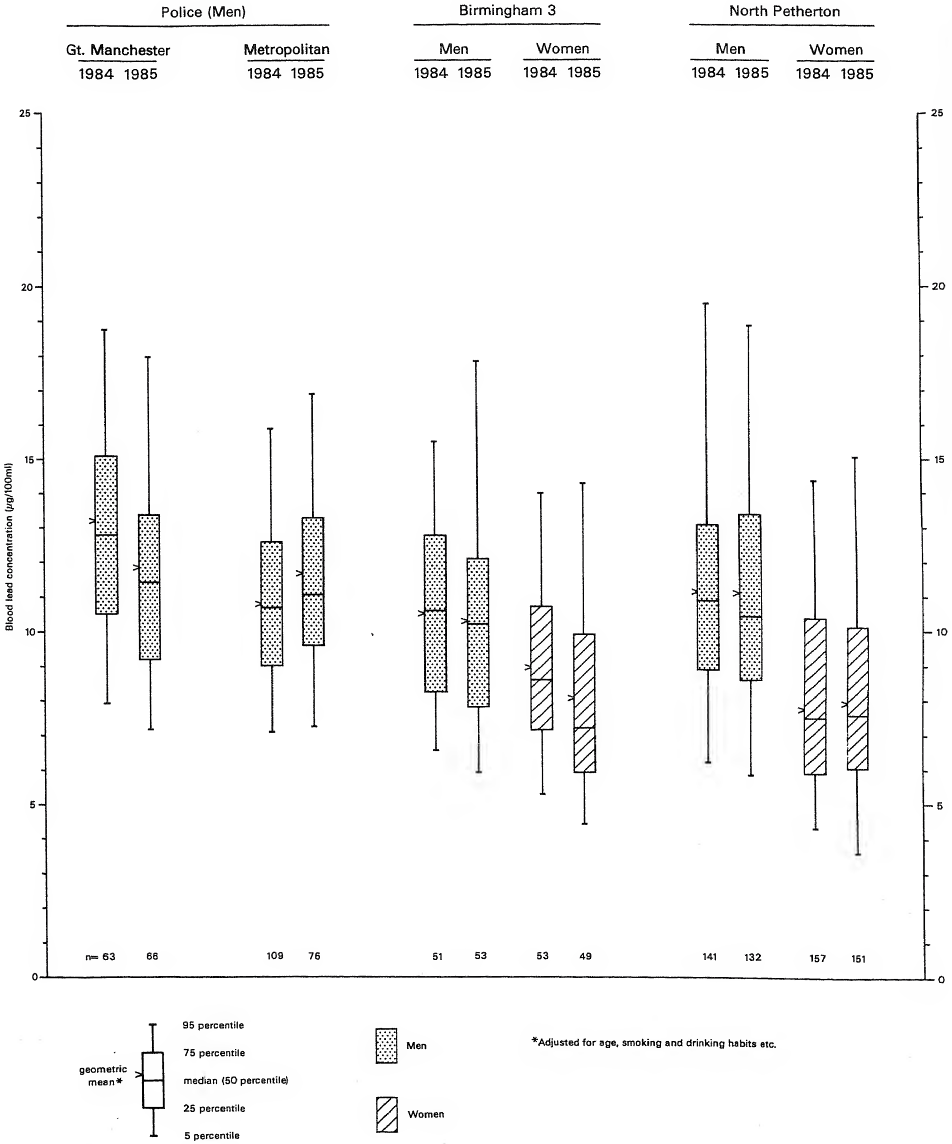
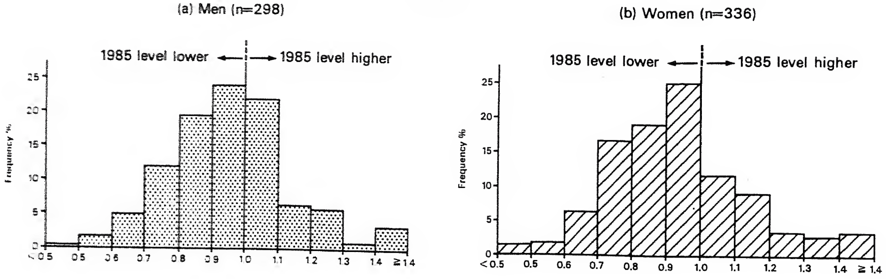


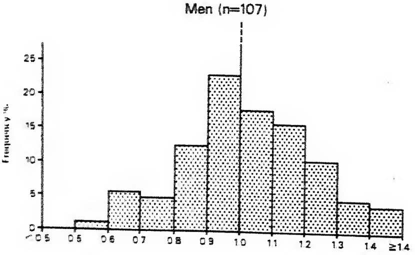
Figure 13

Frequency distributions of the ratio of blood lead concentration in 1985 to that in 1984, for adults sampled in both years*

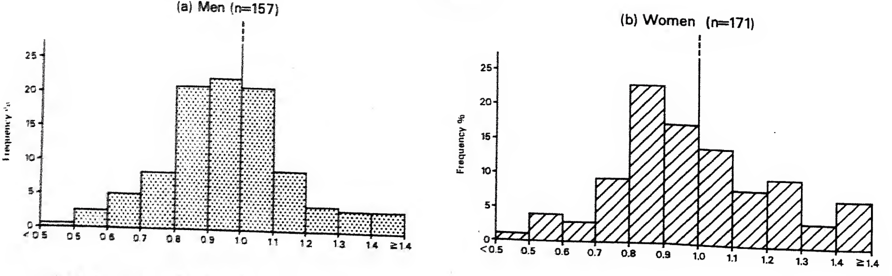
1. Exposed



2.Police



3. Controls

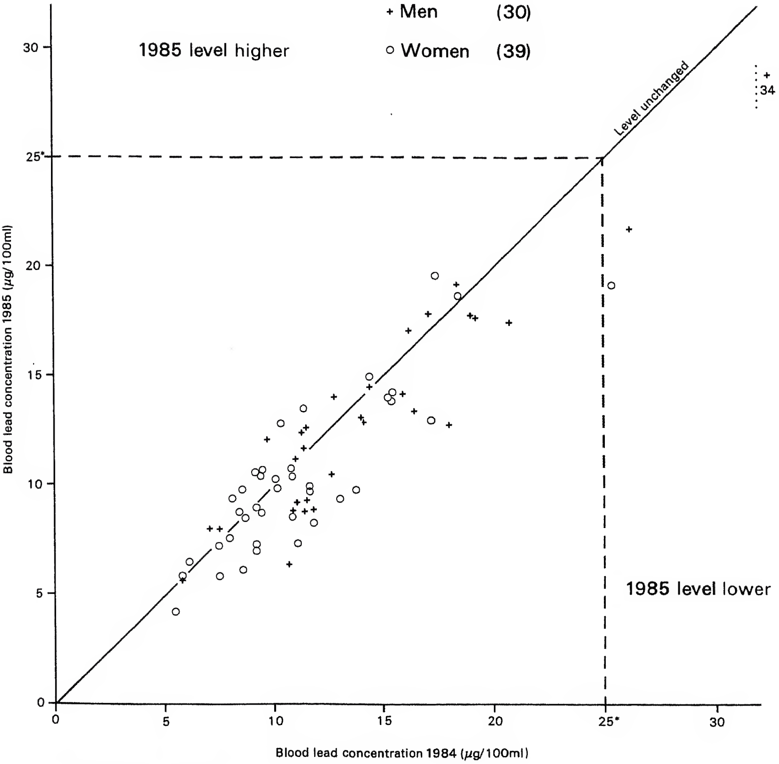


* excluding those with blood lead concentrations above 25 μg/100ml in either year

blood lead level 1985 / blood lead level 1984

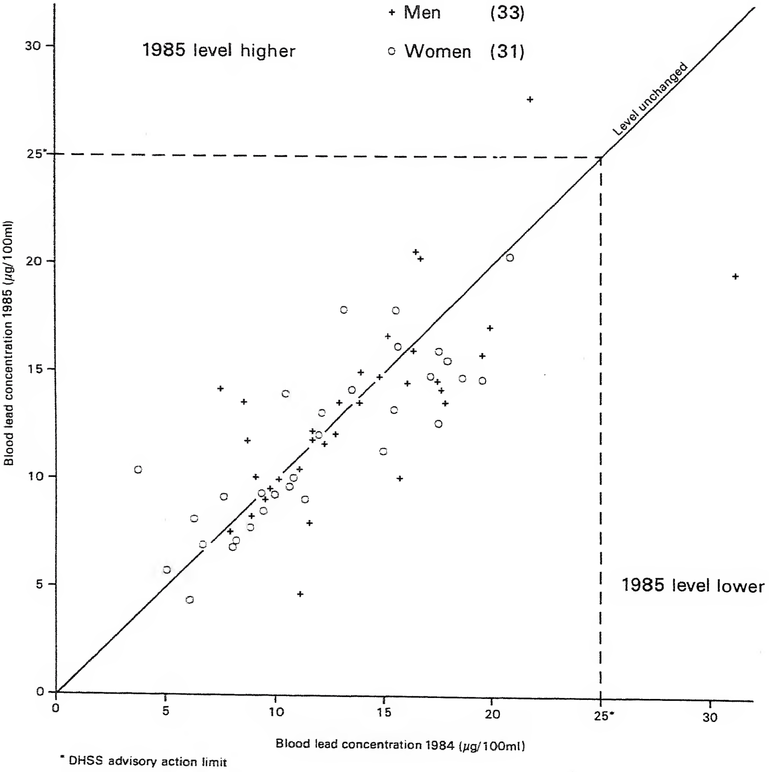
Figure 14 (a)

## Serial blood lead concentrations 1984 and 1985
## Birmingham 1

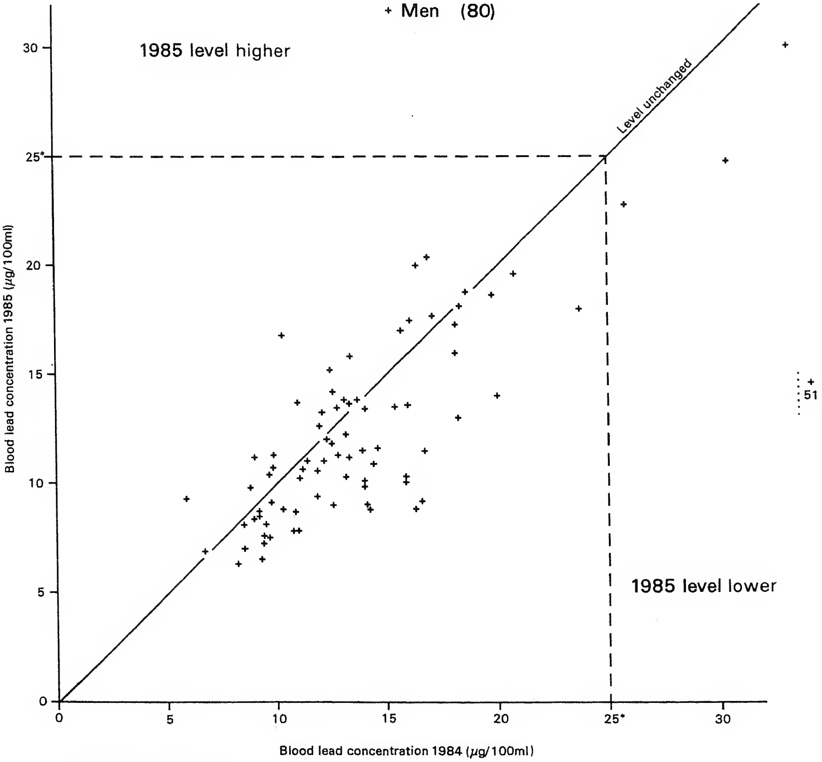


* DHSS advisory action limit

## Serial blood lead concentrations 1984 and 1985
## Birmingham 2



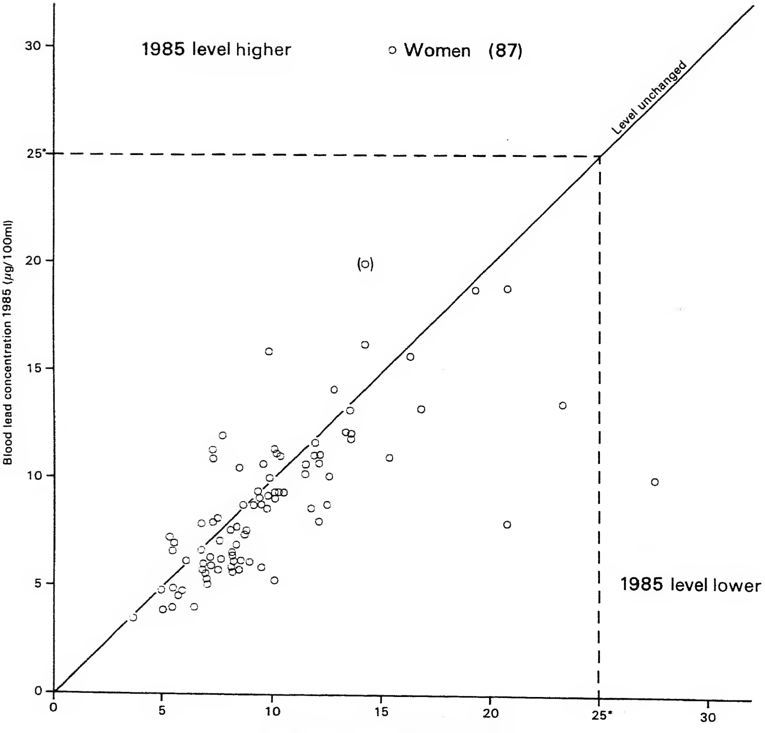
## Serial blood lead concentrations 1984 and 1985
## Bristol - Men



* DHSS advisory action limit

Figure 14 (d)

## Serial blood lead concentrations 1984 and 1985
## Bristol - Women

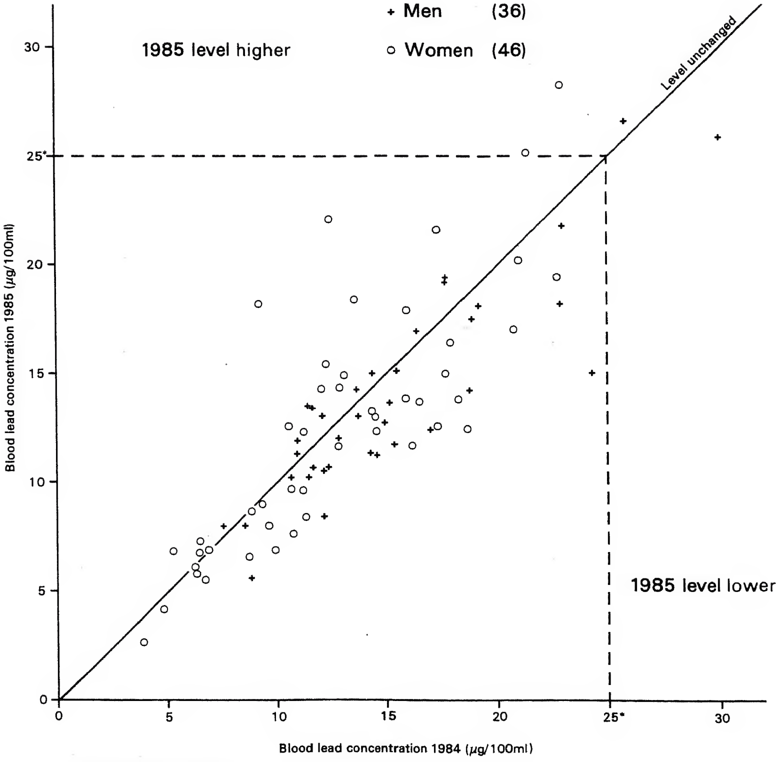


* DHSS advisory action limit

( ) small sample in 1985 - result unreliable

Figure 14 (e)

## Serial blood lead concentrations 1984 and 1985
## Liverpool



* DHSS advisory action limit

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# Serial blood lead concentrations 1984 and 1985
## Waltham Forest

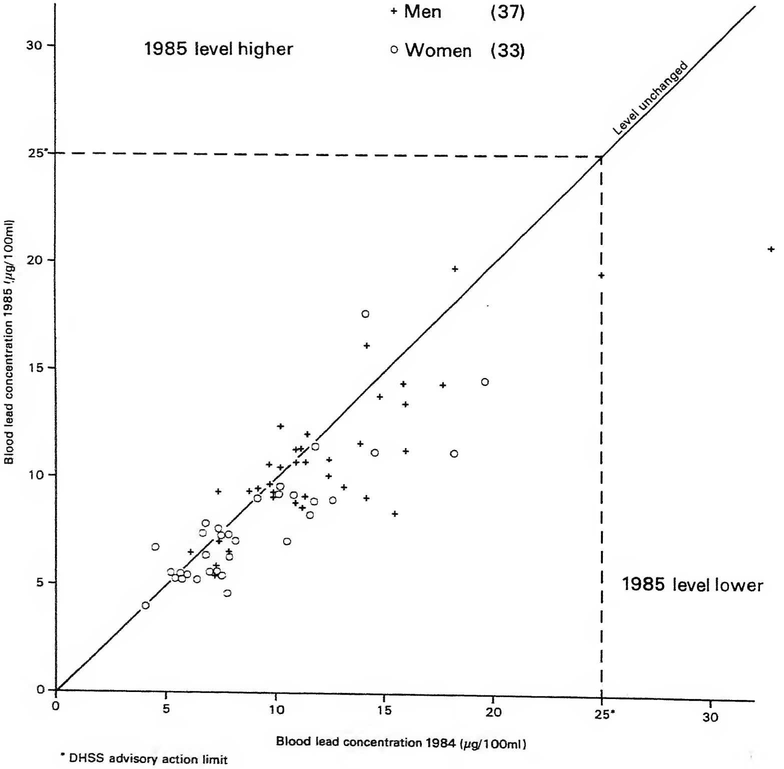
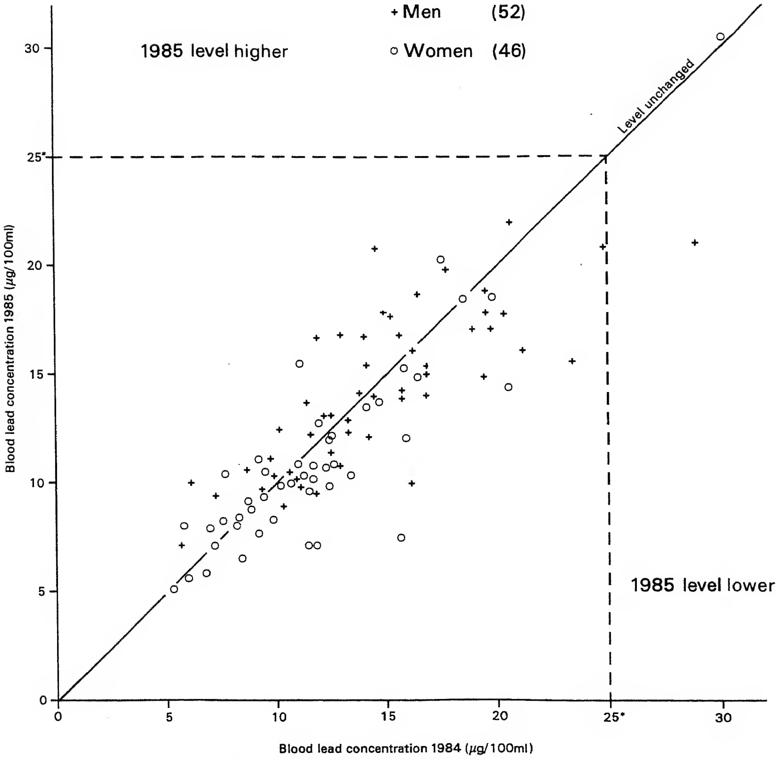


Figure 14 (g)

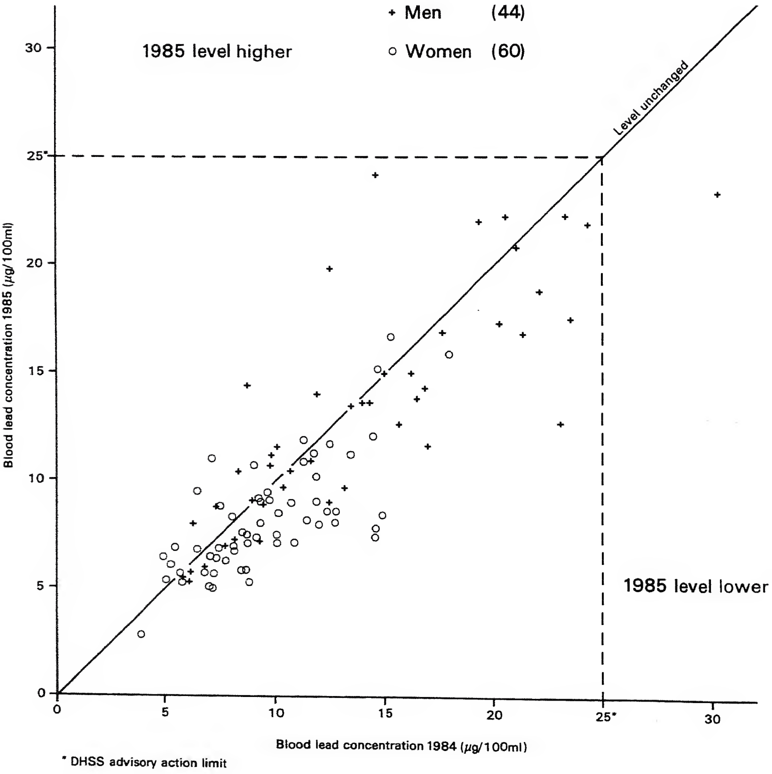
# Serial blood lead concentrations 1984 and 1985
# Manchester



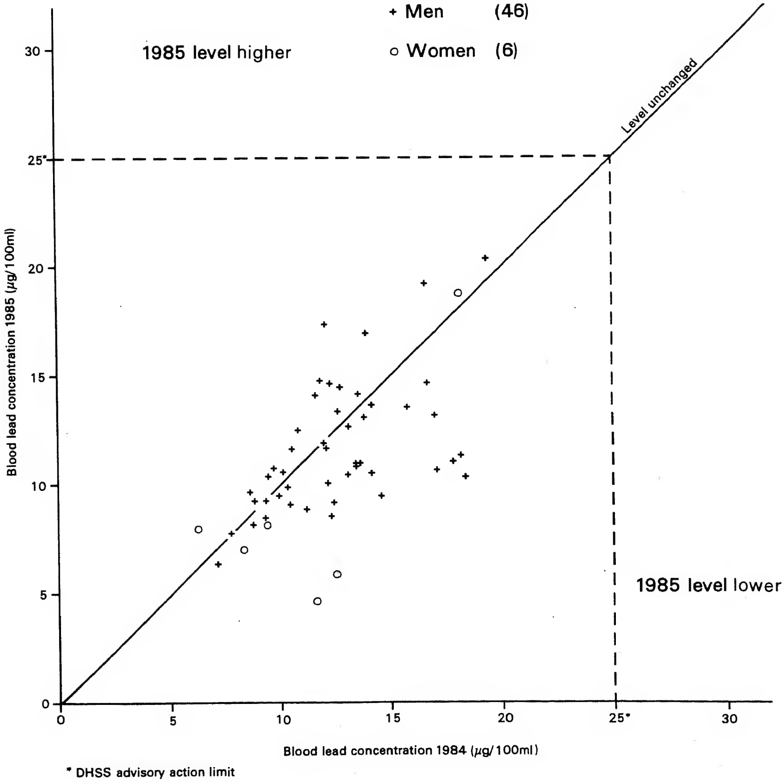
* DHSS advisory action limit

Figure 14 (h)

## Serial blood lead concentrations 1984 and 1985
## Sheffield



# Serial blood lead concentrations 1984 and 1985
# Greater Manchester Police



* DHSS advisory action limit

Figure 14 (j)

Serial blood lead concentrations 1984 and 1985
Metropolitan Police

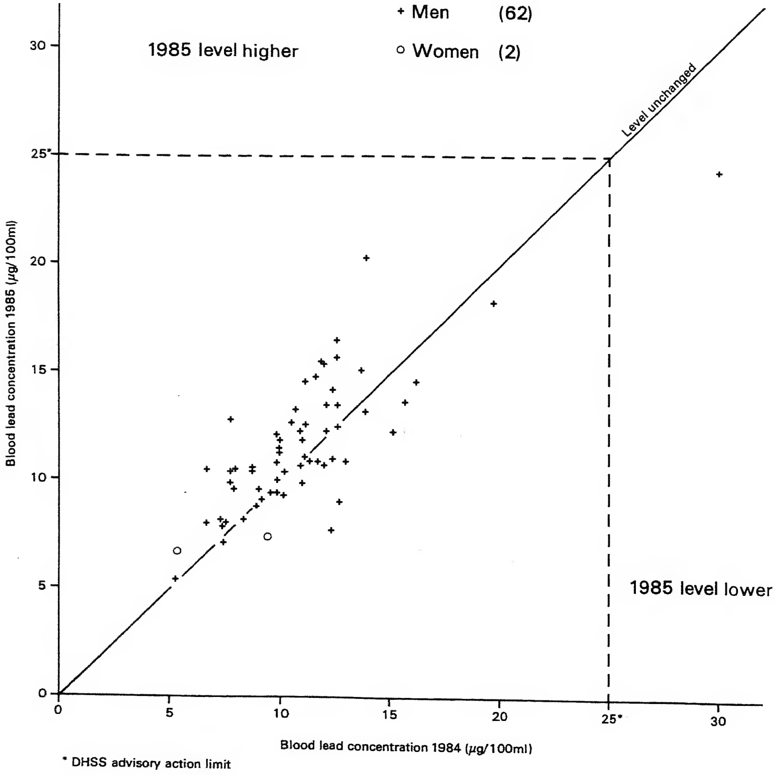
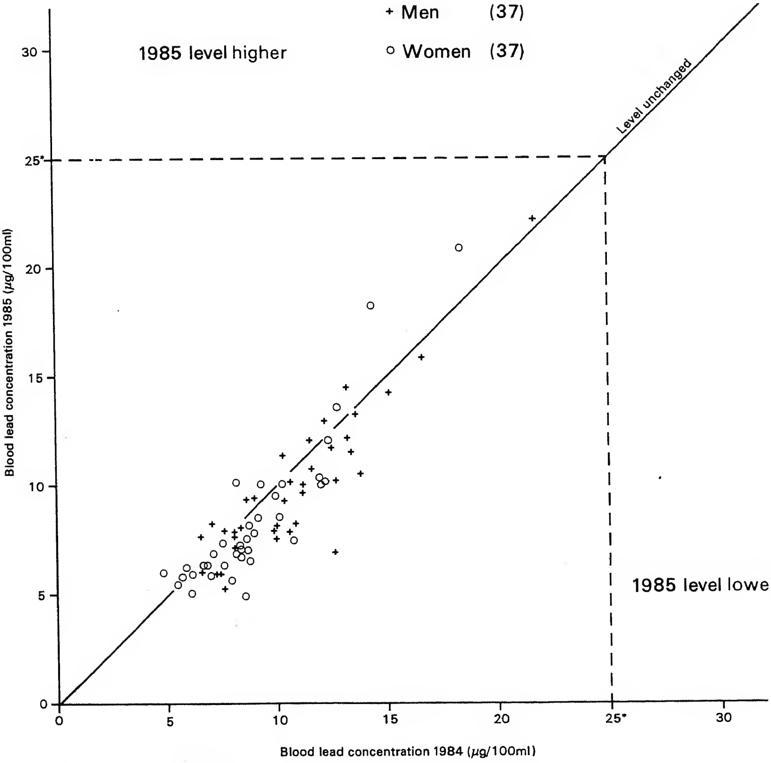


Figure 14 (k)

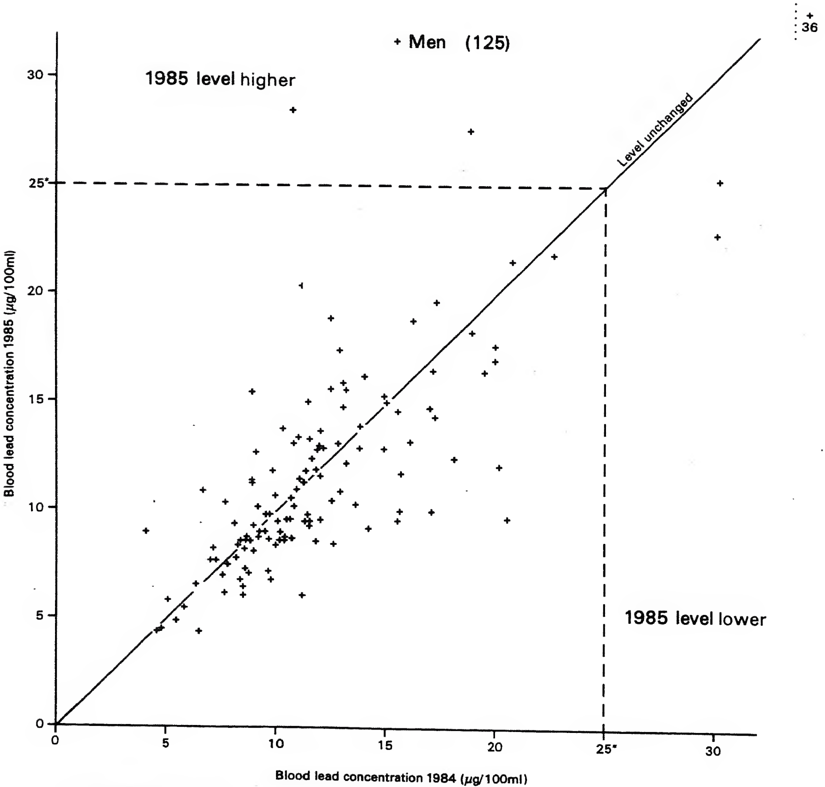
## Serial blood lead concentrations 1984 and 1985
## Birmingham 3



* DHSS advisory action limit

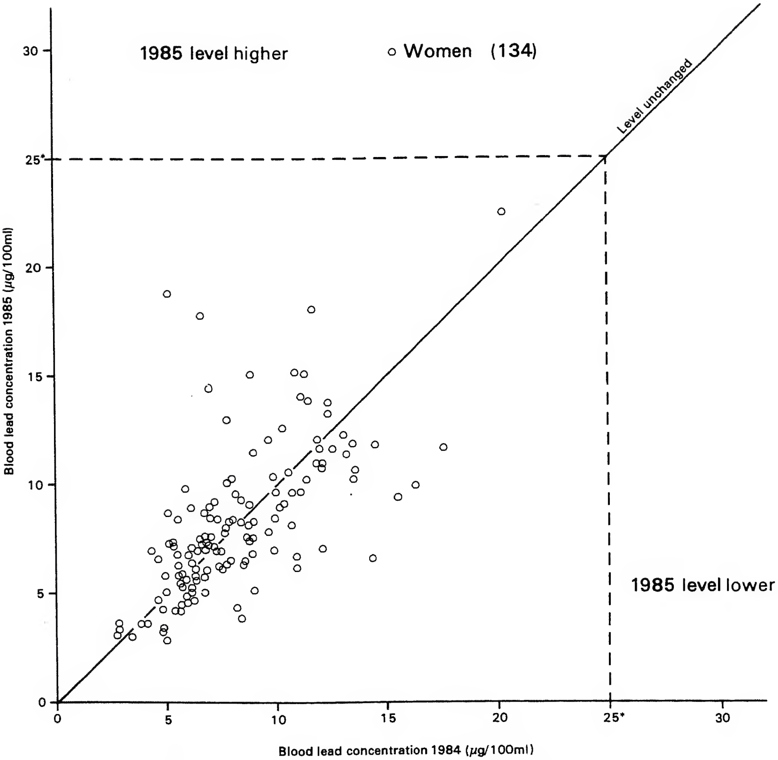
Figure 14 (I)

## Serial blood lead concentrations 1984 and 1985
## North Petherton - Men



* DHSS advisory action limit

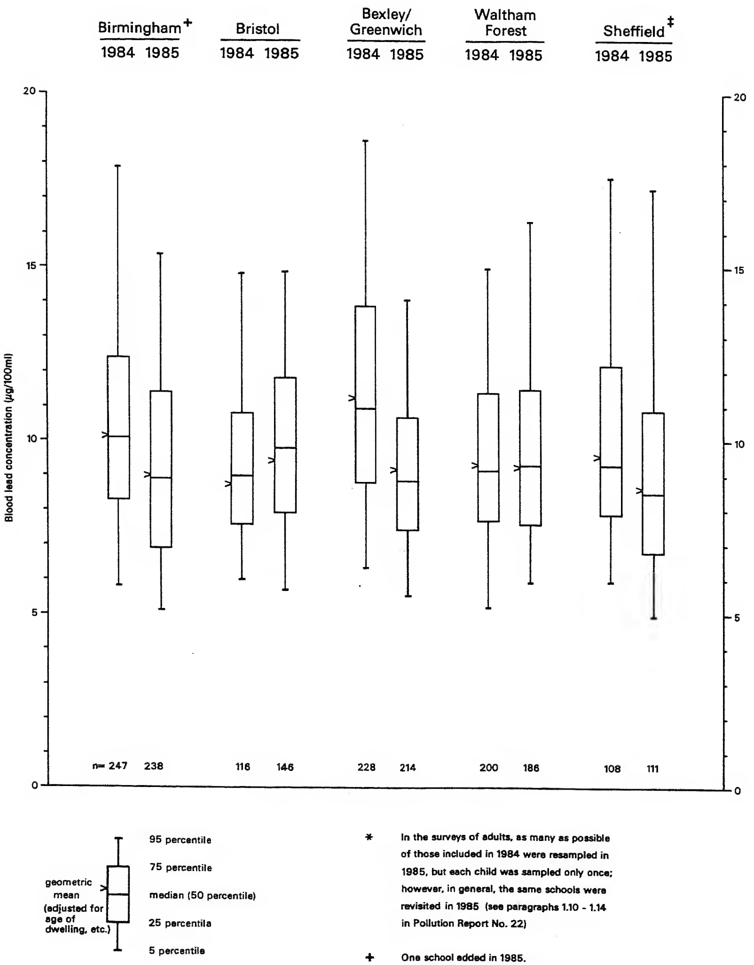
## Serial blood lead concentrations 1984 and 1985
## North Petherton - Women



* DHSS advisory action limit

Figure 15

## Distributions of blood lead concentrations 1984 and 1985
## Children*



* In the surveys of adults, as many as possible of those included in 1984 were resampled in 1985, but each child was sampled only once; however, in general, the same schools were revisited in 1985 (see paragraphs 1.10 - 1.14 in Pollution Report No. 22)

+ One school added in 1985.

‡ One school dropped out and two were added in 1985.

APPENDIX A

## STEERING COMMITTEE ON ENVIRONMENTAL LEAD MONITORING

List of Members and Observers, 1985

| | |
|---|---|
| Dr D A Everest (Chairman) | Department of the Environment |
| Dr D L Simms | " " " " |
| Mrs M Banks | " " " " |
| Mr O D Hydes | " " " " |
| Mr M J Quinn | " " " " |
| Mr C A Reynolds | " " " " |
| Mr J F A Thomas | " " " " |
| Dr J C Sherlock | Ministry of Agriculture, Fisheries and Food |
| Dr J L Facer | Department of Health and Social Security |
| Mr M St J Fendick | Department of Transport |
| Mr J O Wastle | Scottish Development Department |
| Dr G I Forbes | Scottish Home and Health Department |
| Dr M Williams | Department of Trade and Industry (Warren Spring Laboratory) |
| Mr R A Page | Welsh Office |
| Mr J L Barnett | HM Industrial Air Pollution Inspectorate |
| Mr J Mc D Halliday | Association of County Councils |
| Mr W Cassidy | " " " " |
| Mr D J Barnett | Association of District Councils |
| Mr H H Crabtree | " " " " |
| Mr A Atkinson | Association of Metropolitan Authorities |
| Mr J Hinchliffe | " " " " |
| Mr W T Devenay | Convention of Scottish Local Authorities |
| Dr M Schwar | Greater London Council |
| Mr M Duggan | " " " |

### Observers

| | |
|---|---|
| Dr H T Delves | University of Southampton |
| Dr S J Pocock | Royal Free Hospital |
| Dr D I Magrath | National Institute for Biological Standards & Control |
| Mr S Battersby | Institution of Environmental Health Officers |
| Dr K W Allen | Association of District Medical Officers |
| Dr K A M Grant | " " " " " |

### Secretary

| | |
|---|---|
| Mr R P Davies | Department of the Environment |

# AUTHORITIES WHICH CARRIED OUT SURVEYS IN 1985

City of Birmingham; and Birmingham AHA*.

City of Bristol; and Bristol and Weston AHA.

City of Liverpool; and Liverpool AHA.

London Borough of Brent; and Brent HA.

London Borough of Greenwich; and Bexley AHA and Greenwich AHA.

London Borough of Lambeth; and West Lambeth HA.

London Borough of Waltham Forest; and Redbridge and Waltham Forest AHA.

City of Manchester; and North Manchester AHA, Central Manchester AHA and South Manchester AHA.

North Petherton Surgery; and Somerset AHA.

City of Sheffield; and Sheffield AHA.

Devon and Cornwall Constabulary.

Greater Manchester Police.

Metropolitan Police.

* Area Health Authority

## STATISTICAL METHODS

C.1 This Appendix contains a brief description of the statistical terms and methods used; a more detailed explanation, together with some examples, was given in Appendix F of Pollution Report No 18 (12).

### Geometric Mean and Geometric Coefficient of Variation

C.2 The frequency distributions of blood lead concentration in the groups surveyed in 1984 and 1985 were not symmetric, but were positively skewed (Chapters 3 and 4; Table 7; Figure 6). The distributions were approximately lognormal, ie the logarithm of the blood lead concentration followed a Gaussian or "normal" distribution (47). Having taken logarithms, the standard statistical methods based on "normal" theory apply, and it is possible to carry out Student's t tests for the significance of the difference between means, or to estimate confidence intervals, etc. However, the results of any statistical analyses on the logarithmic values need to be converted back to the original scale of measurement so that they can be readily understood.

C.3 The natural measure for the location of a lognormal distribution is the geometric mean (GM) which is the antilogarithm of the simple or arithmetic mean (m) of the log transformed values:

$$m = \frac{1}{n} \sum_{i=1}^{n} \log_e x_i$$

$$GM = \text{antilog}_e\ (m) = e^m$$

where $x_i$ ($i = 1, 2, \ldots\ldots, n$) are the blood lead concentrations in the sample.

C.4 In parallel with the geometric mean, the antilogarithm of the standard deviation (s) of the log transformed values, called the geometric standard deviation (GSD), is often used to measure dispersion:

$$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (\log_e x_i - m)^2}$$

$$\text{GSD} = \text{antilog}_e (s) = e^s$$

where $x_i$ ($i = 1, 2, \ldots, n$) are the blood lead concentrations in the sample, and m is the mean of the log transformed values. One disadvantage with this is that in the conversion back to the original scale of measurement the GSD becomes a multiplicative measure which can be difficult to interpret. Also, it can easily be confused with the ordinary standard deviation which is an additive measure of the variation expressed in the same units as the mean.

C.5 A more useful alternative to the geometric standard deviation is to calculate the equivalent of what is called the "coefficient of variation" (CV), which (in the arithmetic scale) is simply the standard deviation expressed as a percentage of the mean, ie

$$\text{CV} = \frac{\text{arithmetic standard deviation}}{\text{arithmetic mean}} \times 100\%.$$

The analogous statistic for the log transformed values is the geometric coefficient of variation (GCV) which is defined (48) to be:

$$\text{GCV} = (\text{GSD} - 1) \times 100\%.$$

C.6 Although the GCV is, like the GSD, a multiplicative measure of dispersion, it is expressed as a percentage and is therefore much less likely to be thought to be an additive measure or to be confused with the arithmetic standard deviation. The GCV gives a much more useful indication of the dispersion of a lognormal distribution because there is a similar measure (the ordinary coefficient of variation) in the arithmetic scale. Further, it is very much easier with the GCV than with the GSD to get a reasonable impression of the difference between the dispersions of two lognormal distributions with similar geometric means.

## Box Plots

C.7 This paragraph describes the method used in this report to display some of the comparisons of the results for 1984 and 1985. The usual way of presenting a blood lead distribution in graphical form is the simple histogram - see Figure 6.

In the histogram, blood lead levels are grouped in ranges (here 0 to 5 µg/100ml, 5 to 10, etc) on the horizontal axis and the frequency of occurence of levels in those ranges is indicated by the heights of the "bar". This histogram of actual values is an approximation to the underlying distribution, which has been found to be "lognormal" as shown at A and B respectively in Figure C1. Such distributions are usually summarised by the mean and standard deviation, but a fuller picture of the distribution can be given by the "box plot" (51) which presents in graphical form several of the percentiles of the distribution. Here - C in Figure C1 - the 5, 25, 50 (the median), 75 and 95 percentiles have been chosen. The bottom and top 5% of the distribution are effectively ignored - the top end particularly can contain "freak" values and in addition the maximum value (often quoted) tends to increase with the sample size. The middle half of the distribution is indicated by the "box" which is divided by a line at the median value. When comparing two distributions, the superimposing of two histograms can be difficult to interpret, particularly if the distributions are fairly similar; comparisons of three or more distributions are almost impossible. However, with the different representation given by the "box plot", it becomes possible to display, graphically, several distributions alongside each other and a rapid visual assessment of any differences between them can be made quite easily.

## Representativeness

C.8 A full discussion of the representativeness of the samples in 1984 was given in paragraphs C.18 to C.22 in Appendix C of Pollution Report No 22(2). The corresponding comparisons for the 1985 results with information from the GHS (26, 45) and the NDHS (46) are given in Tables C1 to C7.

C.9 Comparisons have been made of the characteristics of those adults who participated in 1984 and who subsequently did and did not also participate in 1985. Table C8 contains, separately for men and women, the percentages of people in each of the various sub categories of six of the main socio-economic factors, together with the corresponding average blood lead concentrations (not adjusted for any of the other factors, nor for geographical location). The overall follow- up rates for men and women were very similar in both the exposed and control groups (Table 20). The only marked difference in the various sub categories of the six factors that was consistent for both men and women was that there were (proportionately) more people in the lowest age group (16 to 29 years) among those who dropped out.

## Multiple Regression Analysis

C.10 The results from the individual surveys indicated that several of the personal and social factors about which information was obtained on the questionnaire appeared to be related to blood lead concentrations, while others did not (Tables 8 to 17 ). But it is possible that these straightforward results might exaggerate the separate effects of each factor in cases where they were inter-related. For example, in the EEC Blood Lead Surveys, the random samples of adults in major cities showed that the apparent average difference in blood lead levels between the inner and other areas of the cities was nearly 2 µg/100ml (11). However, the inner city areas contained relatively more older dwellings (which tend to have lead plumbing and to contain old lead paint) and relatively more participants who were heavy smokers. A statistical analysis showed that the difference in blood lead levels between the inner and outer areas - after allowing for differences in the proportions of older dwellings, etc - was in fact about 1 µg/100ml (4, 13).

C.11 One statistical technique which can be used to investigate possible relationships between a number of factors and the variable of interest is called multiple linear regression. If it can be assumed that the relationship between blood lead concentration and any one of the factors is linear for each of them given any values of the other variables, the statistical model is then

$$y = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_p x_p + \epsilon$$

where $y$ = blood lead concentration

$\alpha$ = a constant (called the "intercept")

$\beta_i$ = constants (called the "partial regression coefficients")

$x_i$ = "explanatory" variables (eg age, sex, etc)

$p$ = the number of "explanatory" variables

$\epsilon$ = a residual term - the variability not accounted for by the explanatory variables.

The various values of $\epsilon$ for different individuals are assumed to be independently distributed with zero mean and known variance. The coefficient $\beta_i$ is the amount by which $y$ changes on average when variable $x_i$ changes by 1 unit and all the other variables remain constant. If there are more observations available than the number of independent variables, the standard "least squares" statistical theory of linear regression can be applied to obtain estimates of the coefficients $\beta_i$ (18).

C.12 A problem arises, however, with the usual type of multiple linear regression when the independent variables are not continuous, as is height, but fall into only a small number of separate categories, eg ethnic origin. In such cases, the regression technique can be modified slightly by including what are called "dummy variables" (52). This modification has the advantage that it does not require any assumptions about whether or not any relationships between the variables in question are linear. Each dummy variable, which can take only the values 1 or 0, indicates whether (or not) a person falls within a particular category.

C.13 The results of the statistical calculations were actually produced in the form of a "multiple classification analysis" (49). This analysis is based on the regression coefficients (as in the equation in paragraph C.11), and gives the overall mean value of the dependent variable, and the differences from the overall mean for each category of a variable such as social class (52). The best fit of the models was obtained when the logarithm of blood lead concentration was used as the dependent variable; thus the additive effects for each independent variable in the logarithmic scale represent multiplicative factors back in the original scale of measurement.

## Statistical Significance

C.14 Unless otherwise indicated, any differences between average blood lead concentrations mentioned in the text were statistically significant at the 5 per cent level (one-sided test). Differences in average blood lead concentrations for those adults sampled in both 1984 and 1985 (paragraph 5.4 and Table 21) were assessed using paired t tests.

## Table C1 Social Class, 1985

| | | Social Class | | | | |
|---|---|---|---|---|---|---|
| | | I&II | IIInm | IIIm | IV&V | Other |
| Men | BLMP | 24 | 34 | 30 | 11 | 2 |
| | GHS | 22 | 17 | 36 | 22 | 3 |
| Women | BLMP | 20 | 47 | 10 | 17 | 6 |
| | GHS | 19 | 25 | 26 | 24 | 5 |

## Table C2 Smoking by Age, 1985

| | | | % smokers in age group* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 16-20 | 21-25 | 26-35 | 36-50 | 51-60 | over 60 | Total |
| Men | BLMP | cigarettes | (24) | 37 | 34 | 24 | 27 | 23 | 27 |
| | | all smokers | (29) | 44 | 40 | 38 | 39 | 32 | 38 |
| | GHS** | | 29 | 40 | 40 | 39 | 39 | 30 | 36 |
| Women | BLMP | | (19) | 30 | 44 | 34 | 34 | 20 | 33 |
| | GHS | | 32 | 36 | 36 | 36 | 39 | 23 | 32 |

* includes police officers, as their smoking habits were similar to those of other participants in the same age and social class groups (Table 10).

** age bands 16-19, 20-24 etc [reference (26)].

## Table C3 Smoking by Social Class, 1985

| | | | % smokers in social class | | | | |
|---|---|---|---|---|---|---|---|
| | | | I&II | IIInm | IIIm | IV&V | Total |
| Men | BLMP | cigarettes | 18 | 24 | 36 | 37 | 27 |
| | | all smokers | 33 | 34 | 44 | 43 | 38 |
| | GHS | | 26 | 30 | 40 | 46 | 36 |
| Women | BLMP | | 34 | 31 | 39 | 39 | 33 |
| | GHS | | 26 | 28 | 37 | 37 | 32 |

BLMP The UK Blood Lead Monitoring Programme, 1985
GHS General Household Survey (26, 45)

## Table C4 Light & Heavy Cigarette Smokers, 1985

| | | % cigarette smokers | |
|---|---|---|---|
| | | "light"<br>1-20/day | "heavy"<br>>20/day |
| Men | BLMP | 73 | 27 |
| | GHS | 56 | 44 |
| Women | BLMP | 86 | 14 |
| | GHS | 68 | 32 |

## Table C5 Drinking Habits, 1985

| | | Drinking Category* | | | | | |
|---|---|---|---|---|---|---|---|
| | | Teetotal | Occasional | Infrequent Light | Frequent Light | Moderate | Heavier |
| Men | BLMP | 17 | 20 | 13 | 16 | 24 | 10 |
| | GHS | 7 | 9 | 12 | 38 | 14 | 20 |
| Women | BLMP | 17 | 34 | 13 | 18 | 16 | (1) |
| | GHS | 13 | 20 | 19 | 42 | 4 | 2 |

* See Chapter 1

## Table C6 Social Class - Children, 1985

| | Social Class | | | | |
|---|---|---|---|---|---|
| | I&II | IIInm | IIIm | IV&V | Other |
| BLMP | 24 | 13 | 42 | 18 | 4 |
| GHS | 22 | 17 | 36 | 22 | 3 |

## Table C7 % Pre-1945 Dwellings - Children, 1985

| | Birmingham | Brent | Bristol | Bexley/ Greenwich | Waltham Forest | Sheffield |
|---|---|---|---|---|---|---|
| BLMP | 63 | 75 | 65 | 29 | 72 | 69 |
| NDHS | 61 | 65 | 66 | 66 | 78 | 59 |

BLMP The UK Blood Lead Monitoring Programme, 1985
GHS General Household Survey (26, 45)
NDHS National Dwelling and Housing Survey (46)

Table C8 Comparisons of the characteristics of adult participants* in 1984 who did and did not also participate in 1985+

| (a) Age (years) | | 16-29 | | 30-44 | | 45-59 | | 60-74 | | 75 and over | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | PbB# | % | PbB | % | PbB | % | PbB | % | PbB |
| Men | in 1985 | 19 | 10.8 | 35 | 11.8 | 26 | 12.5 | 18 | 12.4 | 3 | (11.6) |
| | dropped out | 27 | 11.1 | 36 | 12.1 | 23 | 12.3 | 10 | (12.0) | 4 | .. |
| Women | in 1985 | 16 | 8.4 | 36 | 8.6 | 29 | 10.1 | 15 | 9.8 | 3 | (10.0) |
| | dropped out | 30 | 7.2 | 26 | 9.1 | 22 | 10.9 | 16 | 10.1 | 5 | .. |

| (b) Social Class | | I&II | | IIInm | | IIM | | IV&V | | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| | | % | PbB | % | PbB | % | PbB | % | PbB | % |
| Men | in 1985 | 28 | 11.7 | 30 | 11.4 | 26 | 12.9 | 15 | 11.6 | 1 |
| | dropped out | 19 | 11.6 | 47 | 11.7 | 25 | 12.7 | 8 | (10.6) | 1 |
| Women | in 1985 | 20 | 9.6 | 45 | 9.1 | 9 | 9.4 | 20 | 9.2 | 7 |
| | dropped out | 19 | 9.8 | 39 | 9.4 | 9 | 8.3 | 25 | 9.0 | 7 |

| (c) Smoking Habits | | Non-smoker | | Cigar/pipe | | 1-20 cigs/day | | >20 cigs/day | |
|---|---|---|---|---|---|---|---|---|---|
| | | % | PbB | % | PbB | % | PbB | % | PbB |
| Men | in 1985 | 61 | 11.4 | 9 | 11.7 | 22 | 12.8 | 7 | 14.0 |
| | dropped out | 64 | 11.4 | 6 | (12.4) | 21 | 12.2 | 9 | (13.9) |
| Women | in 1985 | 69 | 8.6 | 1 | .. | 26 | 10.4 | 4 | 11.1 |
| | dropped out | 56 | 8.5 | 1 | .. | 37 | 9.8 | 6 | .. |

**Table C8 Comparisons of the characteristics of adult participants[*] in 1984 who did and did not also participate in 1985[+] (contd)**

| (d) Drinking Heavy | | Teetotal | | Occasional | | Light | | Moderate | | Heavier | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | PbB | % | PbB | % | PbB | % | PbB | % | PbB |
| Men | in 1985 | 7 | 12.3 | 24 | 10.8 | 29 | 11.8 | 30 | 12.3 | 10 | 13.1 |
| | dropped out | 10 | 11.0 | 19 | 11.8 | 30 | 11.6 | 36 | 11.9 | 4 | .. |
| Men | in 1985 | 17 | 8.5 | 43 | 8.8 | 23 | 9.9 | 16 | 10.0 | 2 | (9.7) |
| | dropped out | 21 | 7.9 | 30 | 9.1 | 25 | 9.3 | 20 | 9.9 | 4 | .. |

| (e) Age of Dwelling | | Pre-1945 | | Post-1945 | | nk |
|---|---|---|---|---|---|---|
| | | % | PbB | % | PbB | % |
| Men | in 1985 | 72 | 12.2 | 28 | 11.1 | – |
| | dropped out | 65 | 12.4 | 33 | 10.8 | 2 |
| Women | in 1985 | 75 | 9.4 | 25 | 8.1 | – |
| | dropped out | 78 | 9.2 | 21 | 8.6 | 1 |

| (f) Length of Residence (yr) | | ≤5 | | 6-10 | | 11-15 | | 16-20 | | >20 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | PbB | % | PbB | % | PbB | % | PbB | % | PbB |
| Men | in 1985 | 35 | 11.7 | 22 | 11.6 | 13 | 12.3 | 12 | 11.8 | 18 | 12.3 |
| | dropped out | 43 | 11.6 | 20 | 12.5 | 11 | 11.7 | 11 | 10.7 | 16 | 12.6 |
| Women | in 1985 | 29 | 8.9 | 22 | 8.6 | 11 | 9.2 | 15 | 9.4 | 22 | 10.0 |
| | dropped out | 32 | 8.0 | 23 | 9.2 | 8 | (10.5) | 14 | 9.6 | 23 | 9.8 |

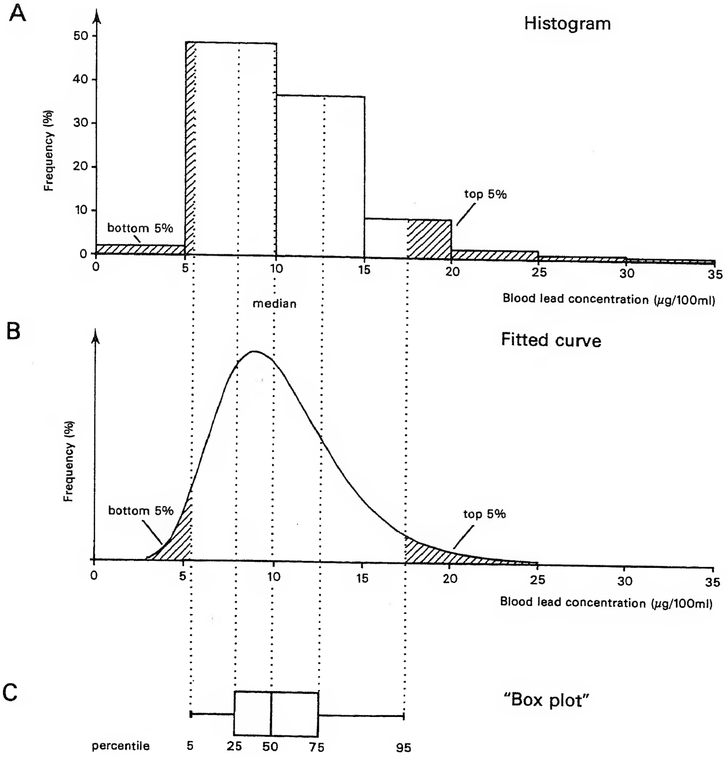
---

* Based on results for 562 men and 516 women who participated in 1985 and on 183 men and 140 women who did not.

+ Excluding those with blood lead concentration above 25µg/100ml in either year.

# Geometric mean blood le ntrations (µg/100ml), not adjusted for other factors.

## Representation of blood lead distributions



# UK BLOOD LEAD MONITORING PROGRAMME 1984-1987

## QUESTIONNAIRE - ADULTS

USED IN 1985

# MONITORING BLOOD LEAD CONCENTRATIONS 1984-1987

IDENTIFICATION NUMBER*

1985

**IN CONFIDENCE**

☐ ☐☐☐☐

LA CODE LETTER

PERSONAL NUMBER

ADULT

PART 1: PERSONAL DETAILS

THIS PART TO BE RETAINED BY LOCAL AUTHORITY

DO NOT RETURN TO DOE

Availability for blood sample

Date

Time

1.1 Surname

1.2 First name(s)

1.3 Home address

1.4 Telephone

Home

Work

1.5 Result to be reported

| (1) to Subject | | (2) to General Practitioner |
|---|---|---|
| ☐ | Yes | ☐ |
| ☐ | No | ☐ |
| ☐ | Only if elevated PbB | ☐ |

1.6 General Practitioner

Name

Address

* See Notes for Guidance

IDENTIFICATION NUMBER*

| LA CODE LETTER | PERSONAL NUMBER |
|---|---|
| ☐ | ☐☐☐☐ |

1985

**ADULT**

PART 2: BACKGROUND INFORMATION
(TO BE RETURNED TO DOE)

| | | | For DOE use |
|---|---|---|---|
| 2.1 | Area Code* | ☐☐☐☐ | ☐☐☐☐<br>1 2 3 4 |
| 2.2 | Type of survey* | ☐☐☐ | ☐☐☐<br>5 6 7 |
| 2.3 | Date questionnaire completed | ☐☐ day ☐☐ month ☐☐ year | ☐☐☐☐☐☐<br>8 9 10 11 12 13 |
| 2.4 | Ethnic origin * CODE FROM OBSERVATION SEE NOTES FOR GUIDANCE | White ☐ 0<br>African/W Indian ☐ 1<br>Indian/Pakistani/Bangladeshi ☐ 2<br>Other ☐ 3 | ☐<br>14 |
| 2.5 | Sex | Male ☐ 0<br>Female ☐ 1 | ☐<br>15 |
| 2.6 | Date of Birth | ☐☐ month ☐☐ year | ☐☐☐☐<br>16 17 18 19 |
| 2.7 | Years of residence at present address* | ☐☐ | ☐☐<br>20 21 |
| 2.8 | **Dwelling built** | Before 1945 ☐ 0<br>After 1945 ☐ 1<br>Not known ☐ 2 | ☐<br>22 |

* See Notes for Guidance

IDENTIFICATION NUMBER*

☐ ☐☐☐☐

LA CODE LETTER | PERSONAL NUMBER

For DOE use

2.9 Current occupation*

2.9.1 Working ☐ 0 Not working ☐ 1 | ☐ 23

IF NOT WORKING, GO TO Q.2.10

2.9.2 Employee ☐ 0 Self-employed ☐ 1 | ☐ 24

2.9.3 Type of job*

.....................................

.....................................

Manager ☐ Foreman ☐ Other ☐ | ☐ 25

2.9.4 Type of business*

.....................................

..................................... | ☐☐ 26 27

2.9.5 Length of time in present job*

Less than six months ☐ 0 More than six months ☐ 1 | ☐ 28

IF MORE THAN SIX MONTHS, GO TO Q.2.12

All those in current job less than 6 months

2.9.6 Different job within last 12 months? YES ☐ 0 NO ☐ 1 | ☐ 29

IF YES, GO TO Q.2.11; IF NO, GO TO Q.2.12

2.10 All those not currently working*

Have you ever worked? YES ☐ 0 NO ☐ 1 | ☐ 30

IF NO GO TO Q2.12

*See Notes for Guidance

IDENTIFICATION NUMBER*

☐ ☐☐☐☐

LA CODE LETTER — PERSONAL NUMBER

For DOE use

2.11 Previous occupation*

2.11.1 Employee ☐ 0 Self-employed ☐ 1 — ☐ 31

2.11.2 Type of job* — ☐ 32

.......................................

Manager ☐ Foreman ☐ Other ☐

2.11.3 Type of business* — ☐☐ 33 34

.......................................

2.12 Exposure of others in household to occupational lead*

| | YES | NO | Not known | Not applic. | For DOE use |
|---|---|---|---|---|---|
| Spouse | ☐ | ☐ | ☐ | ☐ | ☐ 35 |
| Father | ☐ | ☐ | ☐ | ☐ | ☐ 36 |
| Mother | ☐ | ☐ | ☐ | ☐ | ☐ 37 |
| Other adult | ☐ 0 | ☐ 1 | ☐ 2 | ☐ 3 | ☐ 38 |

2.13 Smoking habits

2.13.1 Cigarettes

| | | | |
|---|---|---|---|
| Never smoke these days | ☐ | 0 | |
| Less than 5 a day | ☐ | 1 | |
| 5-20 a day | ☐ | 2 | ☐ 39 |
| More than 20 a day | ☐ | 3 | |

2.13.2 Pipe or Cigars

YES ☐ 0 NO ☐ 1 — ☐ 40

*See Notes for Guidance

IDENTIFICATION NUMBER*

| ☐ | ☐ ☐ ☐ ☐ |
|---|---|
| LA CODE LETTER | PERSONAL NUMBER |

For DOE use

## 2.14 Drinking habits*

### 2.14.1 Alcohol intake

| | | |
|---|---|---|
| None | ☐ | 0 |
| On special occasions only | ☐ | 1 |
| Once or twice a month | ☐ | 2 |
| Weekends only | ☐ | 3 |
| Daily/most days | ☐ | 4 |

☐ 41

IF NONE GO TO Q.2.14.4

### 2.14.2 Type of drink usually taken

| | | |
|---|---|---|
| **Beer/Cider** | ☐ | 0 |
| Spirits | ☐ | 1 |
| Wine/sherry | ☐ | 2 |
| Mixed beer & spirits | ☐ | 3 |
| Mixed beer, spirits, wine & sherry | ☐ | 4 |

☐ 42

### 2.14.3 How much usually taken on each occasion +

| | | |
|---|---|---|
| 2 drinks or less | ☐ | 0 |
| 3-6 drinks | ☐ | 1 |
| More than 6 drinks | ☐ | 2 |

☐ 43

### 2.14.4 Milk intake

| | | | | | |
|---|---|---|---|---|---|
| On cereals | YES | ☐ 0 | NO | ☐ 1 | ☐ 44 |
| In tea or coffee | YES | ☐ 0 | NO | ☐ 1 | ☐ 45 |
| As a milk drink | YES | ☐ 0 | NO | ☐ 1 | ☐ 46 |

* See Notes for Guidance

+ One drink is a single whisky, gin or brandy, a glass of wine, sherry or port, or half a pint of beer

IDENTIFICATION NUMBER*

LA CODE LETTER

PERSONAL NUMBER

For DOE use

## PART 3: RESULTS OF BLOOD LEAD ANALYSIS (TO BE RETURNED TO DOE)

### 3.1 Blood sampling

Date of collection

day month year

47 48 49 50 51 52

### 3.2 Blood Analysis

#### 3.2.1 Date of analysis

day month year

53 54 55 56 57 58

#### 3.2.2 Blood lead* (µg/100ml)

59 60 61

*See Notes for Guidance

# UK BLOOD LEAD MONITORING PROGRAMME 1984-1987

## QUESTIONNAIRE - CHILDREN

## USED IN 1985

# LINKED BLOOD LEAD / IMMUNE STATUS SURVEYS 1984-1987

IDENTIFICATION NUMBER*

1985

**IN CONFIDENCE**

☐ ☐☐☐☐

LA CODE LETTER    PERSONAL NUMBER

CHILD

PART 1: PERSONAL DETAILS

THIS PART TO BE RETAINED BY
LOCAL AUTHORITY

**DO NOT RETURN TO DOE**

Availability for blood sample

Date ______

Time ______

1.1 Surname ______

1.2 First name(s) ______

1.3 Home address ______

______

______

______

1.4 Telephone Home ______

Parent's Work ______

1.5 Result to be reported

| (1) to Subject's Parent | | (2) to General Practitioner |
|---|---|---|
| ☐ | YES | ☐ |
| ☐ | NO | ☐ |
| ☐ | Only if elevated PbB | ☐ |

1.6 General Practitioner

Name ______

Address ______

______

______

* See Notes for Guidance

IDENTIFICATION NUMBER*

☐ ☐☐☐☐

LA CODE LETTER PERSONAL NUMBER

For DOE use

1985

CHILD

PART 2: BACKGROUND INFORMATION
(TO BE RETURNED TO DOE)

2.1 Area Code* ☐☐☐☐ | ☐☐☐☐ 1 2 3 4

2.2 Type of survey* ☐☐☐ | ☐☐☐ 5 6 7

2.3 Date questionnaire completed

☐☐ day ☐☐ month ☐☐ year | ☐☐☐☐☐☐ 8 9 10 11 12 13

2.4 Ethnic origin*
CODE FROM OBSERVATION
SEE NOTES FOR
GUIDANCE

| | | |
|---|---|---|
| White | ☐ | 0 |
| African/W Indian | ☐ | 1 |
| Indian/Pakistani/Bangladeshi | ☐ | 2 |
| Other | ☐ | 3 |
| Not seen | ☐ | 4 |

☐ 14

2.5 Sex Male ☐ 0 Female ☐ 1 | ☐ 15

2.6 Date of birth

☐☐ day ☐☐ month ☐☐ year | ☐☐☐☐ 16 17 18 19

2.7 Years of residence at present address* ☐☐ | ☐☐ 20 21

2.8 Dwelling built

Before 1945 ☐ 0 After 1945 ☐ 1 Not known ☐ 2 | ☐ 22

* See Notes for Guidance

IDENTIFICATION NUMBER*

☐ ☐☐☐☐

LA CODE LETTER — PERSONAL NUMBER

2.9 Occupation of head of household *

2.9.1 Working ☐ 0 — Not working ☐ 1

IF NOT WORKING, GO TO Q.2.10

2.9.2 Employee ☐ 0 — Self-employed ☐ 1

2.9.3 Type of job*

......................................

......................................

Manager ☐ — Foreman ☐ — Other ☐

2.9.4 Type of business*

......................................

......................................

2.9.5 Length of time in present job*

Less than six months ☐ 0 — More than six months ☐ 1

IF MORE THAN SIX MONTHS, GO TO Q.2.12

Head of Household in current job less than 6 months

2.9.6 Different job within last 12 months? YES ☐ 0 — NO ☐ 1

IF YES, GO TO Q.2.11; IF NO, GO TO Q.2.12

2.10 Head of Household **not currently working***

Have they ever worked? YES ☐ 0 — NO ☐ 1

IF NO, GO TO Q.2.12

For DOE use

☐ 23

☐ 24

☐ 25

☐☐ 26 27

☐ 28

☐ 29

☐ 30

* See Notes for Guidance

IDENTIFICATION NUMBER*

☐ ☐☐☐☐

LA CODE LETTER    PERSONAL NUMBER

For DOE use

2.11 Previous occupation of head of household*

2.11.1 Employee ☐ 0    Self-employed ☐ 1    ☐ 31

2.11.2 Type of job*

.................................

Manager ☐    Foreman ☐    Other ☐    ☐ 32

2.11.3 Type of business*

.................................

☐☐ 33 34

2.12 Occupational exposure to lead of *

| | Yes | No | Not known | Not applic. | For DOE use |
|---|---|---|---|---|---|
| Father | ☐ | ☐ | ☐ | ☐ | ☐ 35 |
| Mother | ☐ | ☐ | ☐ | ☐ | ☐ 36 |
| Other adult in household | ☐ | ☐ | ☐ | ☐ | ☐ 37 |
| | 0 | 1 | 2 | 3 | |

2.13 Drinking Habits*

2.13.1 Milk intake

| | | | | | For DOE use |
|---|---|---|---|---|---|
| in cereals | YES | ☐ 0 | NO | ☐ 1 | ☐ 38 |
| in tea/coffee | YES | ☐ 0 | NO | ☐ 1 | ☐ 39 |
| as a milk drink | YES | ☐ 0 | NO | ☐ 1 | ☐ 40 |

2.13.2 Other types of drink usually taken

| | | | | | For DOE use |
|---|---|---|---|---|---|
| tap water | YES | ☐ 0 | NO | ☐ 1 | ☐ 41 |
| bottled water | YES | ☐ 0 | NO | ☐ 1 | ☐ 42 |
| canned juices | YES | ☐ 0 | NO | ☐ 1 | ☐ 43 |
| other | YES | ☐ 0 | NO | ☐ 1 | ☐ 44 |

* See Notes for Guidance

IDENTIFICATION NUMBER*

☐ ☐☐☐☐

LA CODE LETTER    PERSONAL NUMBER

## PART 3: IMMUNE STATUS TO DISEASES *

For DOE use

### 3.1 Vaccination history

| | | | | | |
|---|---|---|---|---|---|
| 3.1.1 Polio - primary course<br>IF NO, GO TO Q.3.1.3 | YES | ☐<br>0 | NO | ☐<br>1 | ☐<br>45 |
| 3.1.2 Polio - booster | YES | ☐<br>0 | NO | ☐<br>1 | ☐<br>46 |
| 3.1.3 Measles | YES | ☐<br>0 | NO | ☐<br>1 | ☐<br>47 |

### 3.2 Childhood diseases

| | | | | | |
|---|---|---|---|---|---|
| 3.2.1 Measles<br>IF NO, GO TO Q.3.2.3 | YES | ☐<br>0 | NO | ☐<br>1 | ☐<br>48 |
| 3.2.2 Age at which contracted (years) | | | | ☐ | ☐<br>49 |
| 3.2.3 Rubella (German measles)<br>IF NO, GO TO Q.3.3 | YES | ☐<br>0 | NO | ☐<br>1 | ☐<br>50 |
| 3.2.4 Age at which contracted (years) | | | | ☐ | ☐<br>51 |

### 3.3 Additional information

| | | | | | |
|---|---|---|---|---|---|
| 3.3.1 Does the child have any sisters or brothers? | YES | ☐<br>0 | NO | ☐<br>1 | ☐<br>52 |

3.3.2 If YES, what are their ages?

☐☐ ☐☐ ☐☐

☐☐ ☐☐ ☐☐
53 54 55 56 57 58

* See Notes for Guidance

IDENTIFICATION NUMBER*

| | | | | |
|---|---|---|---|---|
| | | | | |

LA CODE LETTER

PERSONAL NUMBER

For DOE use

## PART 4: RESULTS OF BLOOD LEAD ANALYSIS

### 4.1 Blood Sampling

Date of collection

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| day | | month | | year | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| 59 | 60 | 61 | 62 | 63 | 64 |

### 4.2 Blood analysis

#### 4.2.1 Date of analysis

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| day | | month | | year | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| 65 | 66 | 67 | 68 | 69 | 70 |

#### 4.2.2 Blood lead* ($\mu g/100ml$)

| | | |
|---|---|---|
| | | |

| | | |
|---|---|---|
| | | |
| 71 | 72 | 73 |

* See Notes for Guidance

## APPENDIX F

## LIST OF INDUSTRIES ASSOCIATED WITH LEAD EXPOSURE

(This was intended to cover the majority of, but not all, industries associated with lead exposure).

01 Lead mining or mining where lead is an associated impurity.
02 Handling of lead-containing ore*.
03 Lead and zinc smelting.
04 Battery and accumulator manufacture, handling and recycling*.
05 Ceramic and pottery industries and crafts, brick and tile industries.
06 Crystal glass industries.
07 Tin and lead crafts.
08 Plastic industries using lead additives.
09 Solder manufacture and handling.
10 Lead printing and inking.
11 Lead paint manufacture and handling*.
12 Demolition work.
13 Shooting range activities.
14 Lead ammunition manufacture and handling.
15 Lead arsenate spray manufacture and handling*.
16 Manufacture and mixing of organo-lead compounds.
17 Garage mechanics.
18 Occupational exposure to lead petrol fumes*.
19 Persons concerned with lead and tin added to car bodies and persons removing lead paint.
20 Lead pigment manufacture.
00 All other occupations (no lead exposure).

*It was felt that the following additional comments might help the questionnaire administrator.:

02 Handling of lead ore - this would include those involved in its transport.
04 Battery and accumulator manufacture, handling and recycling - this would include railway workers involved in recharging locomotive accumulators.
11 Lead paint manufacture and handling - this mainly refers to anti-rust paint used in building construction and in car painting. Lead chromate paint is also used by road workers painting yellow lines.
15 Lead arsenate spray manufacture and handling - this is still used as an agricultural spray in some areas.
18 Individuals exposed professionally to lead petrol fumes - this would include petrol attendants at garages, policemen in high density traffic areas, road toll collectors on motorways.

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